INTEGRATED EDITION OF THE PETROLEUM ENGINEER

the Petroleum Engineer

FOR MANAGEMENT

SEPT 1960

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ONE DOLLAR PER COPY

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THE PETROLEUM Engineer

FOR MANAGEMENT

NUMBER 10 • VOLUME XXXII • SEPTEMBER, 1960

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at presstime . . . *a last minute round-up of petroleum industry news*

Final agreements with Spain were signed by Tidewater and Sohio in August. As operator Tidewater will go into Spanish Sahara immediately for exploratory work on some 5½ million acres. The firms also have four permits in southwestern Spain. (See E-1 for Global Notebook on Spain and territories.)

Refinery runs were cut back by Gulf and Humble because of oversupply. Gulf will have a 120,000 b/d throughput at Philadelphia plant, which has a 183,000 b/d capacity. The company said 625 employees were laid off. Humble runs in August were 42,000 b/d below a year ago.

A 233-mile, 8-in. pipeline construction project has been dropped from its plans by Peace River Oil Pipe Line (B.C.) Ltd., because of what it terms an impossible condition imposed by the British Columbia Government in granting the permit. (See "Projects", this issue.)

An agreement to construct a petrochemical complex in Spain has been reached between Dow and Union Quimica del Norte de Espana S.A. (Unquinesa), announced C. B. Branch, president of Dow Chemical International. The Spanish government has approved the joint venture. The terms call for Dow to purchase a new issue of Unquinesa stock and to supply technological know-how and engineering and marketing assistance. (See Page E-1).

Independent oil operators in Texas have decided to participate in a proposal to persuade oil producing states to develop a formula by which each state would receive a fair share of oil production. Texas Independent Producers and Royalty Owners Association executive committee acted after recent appointment of a special committee by Interstate Oil Compact Commission to study market sharing by the 33 oil-producing states. States are realizing a need for standards through which they may voluntarily evaluate their individual roles in balancing supply with demand, TIPRO stated.

American companies own more than 57% of the world's refining resources, a Petroleum Information Bureau study of world refinery ownership reveals. U.S. interests own a total of 666,000,000 tons of refining capacity, of which 460,000,000 tons are located in the United States.

British and Dutch groups own 15.5% of the world's refining capacity with 181,000,000 tons. The Communist bloc controls 147,000,000 tons, of which 125,000,000 is in Russia.

Total world refining capacity is placed at 1,168,665,000 tons, about 23,373,300 bbl per day.

Phillips Petroleum and Sunray Oil (Sunray Mid-Continent) have agreed to exchange all their oil and gas properties and other holdings in Canada for common shares of Pacific Petroleums, Ltd. Pacific's stock will be owned 39% by Phillips and 5.8% by Sunray. The consolidation places an estimated valuation of $315,000,000 on Pacific's assets.

Anderson-Prichard proposes to sell its assets for $123.3 million. Buyers include: Brookston Oil, a new concern; Union Texas Natural Gas; Frankfort Oil Division of Joseph E. Seagram & Sons, and Apco Oil, a newly formed Delaware corporation.

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highlights *and footnotes of the news*

Conoco acquired control of SOPI Mineralprodukte Gm. b.H., a leading independent petroleum marketing organization in West Germany and Austria, announced Albert E. Ernst, vice president. SOPI markets petroleum products through approximately 360 retail outlets.

After six years search for oil, Esso is withdrawing from Turkey. Expenditures of $20 million were made to evaluate its license areas but no oil was found in 11 wells drilled. Socony recently reported good discovery near Mersin, Turkey.

Fourth quarter import allocation for residual was set at 415,000 b/d maximum by Interior Department. This is less than actual imports of 434,400 b/d in 1959 fourth quarter.

Story of World Trade by du Pont tells of international economic revolution that could be a threat or a promise to United States. Get a copy from du Pont Public Relations Department, Wilmington 98, Delaware. You'll have a better picture of present economic dilemma.

Laos, the country in Indo-China that was taken over by pro-communists in August, had received $230 million from USA. Is it more money down the drain? Only oil exploration permit is held by French concern.

Petroleum Equipment Suppliers Association, viewing present economic condition of the industry, called for abandonment of International Petroleum Exposition held in Tulsa. W. K. Warren, exposition president, said he hopes by 1965 improved conditions in the oil business will induce supply firms to change their minds.

Cuban refineries still run, reported a news service in August, but the three plants seized by the Castro government were operating at about 50% capacity. There was promise of more Russian oil but problems were imminent also. Spare parts could come only from USA and spare parts could be needed, because plants were not designed for Russian crude.

Warns TIPRO president, John G. Hurd, Laredo, Texas: "America's self-sufficiency in oil, which has been deemed vital to the security of ourselves and the free world cannot be preserved if conditions in the Middle East are ever allowed to dictate crude oil prices here."

Middle East crude prices have weakened since Russia forced price cuts in India. Result is demand for extra subsidies from oil companies by some Arab governments. Venezuela's success in breaking 50:50 system has inspired Arab nations to seek more. (See Page A-6.)

Marketing headquarters of Gulf Oil Corp. have been transferred from Pittsburgh to Houston, Texas. This follows reorganization for closer cooperation with Gulf domestic operations, which are expanding. (See Page E-16.)

USA loaned YPFB $2.7 million to buy U.S. oilfield equipment. Bolivia's oil entity had been offered credit by USSR. First time a state oil company has been helped in Point IV program. This puts USA aid in direct competition with U.S. oil companies in Bolivia.

Signal Oil and Gas Company's entire home office was moved into its new 16-story building early in August, reported Samuel B. Mosher, chairman. The Signal Building towers over downtown Los Angeles from an elevated site at 1010 Wilshire Boulevard.

Four independent oil companies merged to form Western Oil Corporation with headquarters in Houston. Roland E. Walter is president. Involved were Coastal Plains Oil Company, Moroll, Oveland, and Western Oil and Gas Company. Coastal Plains, publicly held, is surviving company. Net assets are estimated at about $3 million.

Wage hike was granted after a two-day strike against Sohio by the Independent Petroleum Workers Union. A 9¢/hr increase was chalked up after the union dropped demands for a union shop. The company retains also its right to hire part-time workers.

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Memo to Management:

ONE BILL...ONE RESPONSIBILITY
MEANS A BIG SAVINGS TO US...

Whether it's power for a pipeline, refinery or pumping, many oil companies prefer to purchase dependable utility electric power and get all power bills on one convenient monthly invoice. Utility electric power works 24 hours a day or operates on any fractional time schedule . . . in any case you pay only for the power used and eliminate many worries. For details contact your nearest Utility Electric Power Company.

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A list of P.E.P.A. members will be furnished on request.

Course of Oil

we need weapons, too!

THERE ARE TWO international wars going on in the world today: The cold military war that commands our attention and the economic war that gets the brushoff. What's an economic war, anyway?

The Russians can tell you. They're fighting a hot one and they're fighting to win. They pile the resources of a rich country into a juggernaut of offense to knock off business and industry enterprises in the free world.

Let's look at how it's done in the oil industry. Few people in the USA gave a second thought to Castro's expropriation of Esso, Texaco and Shell's refineries in Cuba. They are big oil companies — they can write it off. Maybe. But we can't afford it — us ordinary Americans. It means loss of employment, loss to stockholders, loss to the Internal Revenue Department that finances our military might.

When Soviet offers of cheap crude oil to India forced oil companies there to break the established price for Middle East oil, who let that small incident sink into concern? Those rich oil companies could take their loss, couldn't they?

But here the results spread even farther. In the first place these oil companies strike a close resemblance to a welfare state, except they can't spend more than they can borrow on the market. They have well paid employees with benefits unparalleled in industry, they have thousands of annuitants to provide for, they supply more taxes to governments in the free world than any single industry, they risk huge funds to develop a country's resources and pay the country for the odd chance they may recoup their investment. And they work on a margin of profit so small it would horrify the whalers of old.

The price cut in India will hurt not only the companies involved and those affected by their specific loss — their people and the governments of the Free World who depend on royalties for public expenditures. In time it will reach the producers in every country that has oil. TIPRO has already recognized the danger to its members. When a U. S. oil producer buys less steel, hires fewer men and pays less income tax because Russia reduced oil prices in India, the Kremlin will have an economic battle in its pocket.

The best results — Soviet-view — are yet to come. The growing indifference to exploration, the insidious atrophying of initiative, a minimum profit vacuum into which government controls filter so, in the end, we emulate our adversaries.

The Soviet offers cheap oil abroad when few nations need it worse at home. The price scale is what the government says it is — a man's suit costs five times what it does in the U. S. but oil is cheaper? Of course not. Oil is a weapon in the economic war as surely as missiles are a weapon in the political conflict.

Because we are a free people and our government to a large extent leaves business and industry to determine their individual courses, we've been ahead in the economic war. Our fires of enterprise burn in every country outside the communist conclave. A juggernaut has a hard time quenching the spirit of business expeditions on every side.

But we need new weapons to fight this battle. Read either platform of the two big political parties in our nation and you find no evident comprehension of the economic war we're in. It looks as if they would deprive us of the weapons we have made for ourselves. While Rome burns they plug for a welfare state. When we need stout enterprise to defend our economy and supply our military, we are offered a threat of unbalanced budgets, steady inflation, more taxes. We can't even compete with our friends, much less our enemies.

We need weapons, not burdens, on this economic front. It's a battle the Kremlin has chosen and it cannot be won on their terms — government vs government. Our individual companies can be victorious if they have a ghost of a chance. If they aren't shackled with regulations, bludgeoned with taxes, held up by union demands, business and industry can win this devouring war. And it could well be the most crucial struggle of our century.

— Ernestine Adams

Congrats and $25 for this quip to G. A. KRAFT, 17 Van Berwaerdeweg, The Hague, Netherlands.

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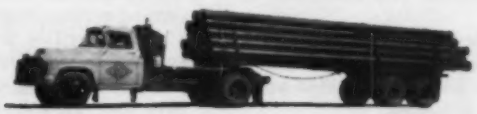

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petroleum profile

LIKE MOST GOOD EXECUTIVES, James L. Sewell has spent all his career preparing for the job he holds — president of Delhi-Taylor Oil Corporation.

Although he has only been with two organizations since he obtained his degree in 1927, he has thorough grounding in every phase of the industry.

But to begin at the beginning — James Sewell is a native Texan, born in Coleman (south of Abilene), where his father had a hardware and machinery store. Jim helped there in the summer when he was growing up and worked at other jobs, too — in the harvest field and with an ice company. When he was in his third year of high school his family moved to Syracuse, New York, and he completed high school there. Then back to Texas, where he obtained his mechanical engineering degree from Texas A&M.

A prize job for graduates at that time was with Worthington Pumps because of its elaborate training course for engineers. Jim went after this job determinedly and he got it. Then followed two years of work at Harrison, New Jersey, Buffalo, New York, Cincinnati, Ohio, and finally

JAMES L. SEWELL

Delhi-Taylor Oil Corporation

Dallas, Texas. By this time he knew a lot about the company and what it could do. In Dallas he was with a contracting engineering company, A. M. Lockett & Company, which represented Worthington, and dealt largely with oil operations.

Sewell was soon sent out to Odessa, West Texas, to run a one-man office. It was during a period when evolution in oil operations was turning rapidly and he was called upon to do about everything the times produced.

"It was a break," he says, and you can see him enjoying the thrill of trying new things. Centrifugal pumps were going into use in pipeline operations. He laid out water systems and oil gathering systems. He did experimental work on production installations and worked on refineries in West Texas. He was doing engineering and servicing in all branches of the oil industry.

Only the largest companies maintained a field engineering staff and engineers were much in demand. Sewell was getting a degree in oil operations no school could provide.

It was at this time that the young man met Gentry L. Rowsey, who was to be a lifelong friend and business associate. Rowsey founded the Taylor Refining Company, named after the Central Texas town, and Sewell did some engineering work for him.

East Texas opened up and activity moved to this new center. Sewell worked for Rowsey in building a 10,000 bbl per day refinery at Tyler and took some stock of the company. This was when he first met Clint Murchison, who later organized Delhi Oil Company.

Still with A. M. Lockett and Company, he was moved to Abilene as a central location between East and West Texas and two years later to Dallas. In 1934 he left the engineering firm to become manager of the Tyler plant until it was sold later that year.

Sewell helped build two more refineries for Rowsey. "They were cheap to build in those days," he recalls.

The 15,000-bbl per day Corpus Christi plant and then the 7000-bbl per day Port Isabel refinery, near Brownsville, Texas, were both onstream at the end of 1935. Sewell was made general superintendent of Taylor Refining Company in 1939 and moved to Corpus Christi.

"We had the best plants available," he said. "You can't compete otherwise." By 1943 he was manufacturing vice president and began to assume more general responsibility. Wartime made heavy demands. The company participated in the aviation gasoline and synthetic rubber programs.

In 1946 Petroleum Heat and Power of New York, an oil distributor and burner manufacturer, merged with Taylor. Three years later Sewell became active in an exploration and drilling program laid out for the growing company. He had specialized in refining operation; now he dived into another phase of the business. When Rowsey retired in 1953 and Sewell was elected president, the new head of Taylor was a man experienced in every division of oil operations.

Then in 1955 Delhi Oil and Taylor Refining were merged, doubling the size and the scope of the separate firms. Delhi-Taylor is a medium size, integrated company, now expanding in petrochemicals and adding to its marketing. In 1956 it became international, venturing into Panama, later into Australia and Guatemala. "Increasing costs of finding oil in the United States made foreign exploration attractive," Sewell explains.

President Sewell does not believe that his company is just a small version of the big corporations. "We have our own form of operations, which are more mobile than those of a large company. For our basic income we stick to the bread and butter of producing, refining, and selling. For the extra we go after prospects with big potential — like our Australian venture. We can't afford slow, capital-consuming projects that pay off only on very long term."

Mr. Sewell is proud of his tight organization, which emphasizes technical control and technical accounting on a basis of the most detailed operational information we've ever seen. He's proud, too, that his company management strives for heavy delegation of authority. One motto is "Keep decisions low and you don't pyramid supervision."

He says, "Get intelligent people and you can run a company efficiently. A man on the job eight hours can make a decision better than the supervisor who's there one hour."

In 1929, he married his Syracuse sweetheart and took her to Odessa. They have four sons. George, who has a geology degree from Texas University, is married and works for British-American in Amarillo. Fred, also married, has a petroleum engineer degree from Texas University and is with Humble at Houston. James is in college at Texas Tech and John is in high school in Dallas.

With that kind of a family and his enthusiastic friends, James Sewell never has any trouble finding a hunting or fishing party.

"Oilwell's" new super-hardened NITRILINE pump barrel is already running up records!

This new, alloy steel pump barrel (bore hardened by our own exclusive and patented Nitrocycle process) is built to last . . . and last . . . and last. It is hard on the inside, tough on the outside . . . and has a close, .001" tolerance. Although the NITRILINE is designed primarily to resist abrasive wear, with a uniform hardness layer end-to-end, it also resists mild corrosion and hydrogen embrittlement.

What operators are saying after testing in their "problem" wells—

Independent Operator, Eastern Illinois: ". . . well had ruined three other barrels in 90 days. The NITRILINE barrel ran 102 days before pulling."

Major Oil Co. Superintendent, West Texas: "We pulled the pump with test NITRILINE barrel after a 60-day run. It looked good. I remember when a 30-day run in this well was considered better than average."

Superintendent for Independent Producer, Rocky Mountains: "Even the 'Oilwell' man was surprised at the 6-month NITRILINE run. We used to replace barrels in that well almost every month."

"Oilwell's" NITRILINE barrel could be just the answer to your problems. Why not pick your most abrasive well and run your own test with this modern barrel? It is priced no higher than other so-called "hard" steel barrels, but should outperform any one of them!

You can get more information about these new NITRILINE pump barrels from the nearest "Oilwell" store or representative.

USS, "Oilwell" and NITRILINE are registered trademarks

USS **Oil Well Supply Division of United States Steel**

Executive Offices: Dallas, Texas
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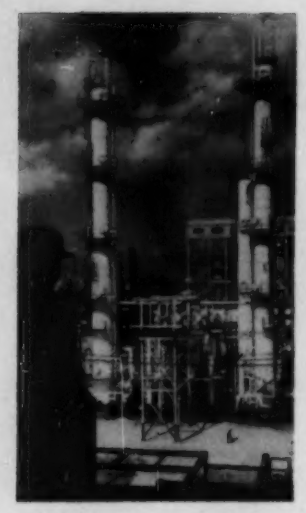


the conference table

USA-USSR Oil Executives Exchange

W. W. Keeler, executive vice president of Phillips Petroleum, heads a party of eight oil executives who will spend a month touring Russia and looking at the Soviet oil industry. Plans were set up by the State Department with the cooperation of API for an East-West exchange. Later Soviet oil executives will come to United States. Besides Mr. Keeler, others in the party will include: W. M. Elias, Pan American Petroleum, Tulsa; Ira H. Cram, Continental Oil; Dr. Noyes S. Smith, Jr., Shell Development; Neal J. Smith, Chevron Oil, all of Houston; George S. Dunham, Socony Mobil, and George T. Piercy, Jersey Standard, both of New York, and George F. Getty II, Tidewater, Los Angeles.

"It's harder to conceal ignorance than to acquire knowledge." — Arnold H. Glasow.

AMA Meeting Studies Political Activity

Joseph Eley, Public Affairs Counselors' president, addresses an American Management Association meeting in New York September 8. This begins a two-day seminar on political activity for business people.

You'll find an article by Mr. Eley in this issue of the *Engineer* on "Evaluate Your Politics." He wrote this especially for the "How to be a Manager" series and it should be read by everyone in every company, including the office boys. Every person who wants to advance in business needs a political philosophy and an understanding of political action in the United States.

Gulf Italia Drops Libel Suit

Gulf's subsidiary in Italy has withdrawn legal action against *L'Unita*, Communist-slanted newspaper, following *L'Unita's* complete retraction of a 1959 story which charged Gulf with "theft."

The alleged "theft" referred to a four billion lire profit noted in Gulf Italia's 1957 annual report. This was considered a "theft," charged the Communist daily newspaper, because Gulf had discovered the Ragusa oil field in 1953 utilizing studies and exploratory data taken away from Italian government offices.

Gulf Italia subsequently filed a libel suit against the editor of *L'Unita* and the writer of the article and produced two suitcases filled with documentary evidence. These documents proved without a doubt that the statement of *L'Unita* was groundless, according to Gulf Italia's vice president, Nicolo Pignatelli Aragona, and that the discovery of the Ragusa oil field was based solely on four years of studies and exploratory activities carried out by Gulf.

Following a recently published statement to this effect and a complete retraction of the erroneous charges by the Italian newspaper, Gulf Italia has withdrawn its suit, Mr. Pignatelli revealed.

"He who hath a profession has an estate." — Ben Franklin.

Here's One Reason for Communists

"Some of our people in Washington seem to lie awake nights trying to think of new ways for government to take over responsibilities that have historically belonged to the individual. History tells us that the most powerful nations which achieved wealth in the past finally became soft through self-indulgence and fell victim to their more vigorous neighbors. Is that to be the fate of America?

"Sometimes I am afraid there would be a real danger of this if the Good Lord had not placed the living threat of the Communist world right before us. Nations, like people, are better off if they have something to strive for. And if that something is to demonstrate to the world that the ideal of freedom in all its manifestations is really achievable by man, then we indeed are a fortunate people."

George Champion, President
The Chase Manhattan Bank

Red-White-and-Blue Tags

Welding fittings manufactured by Tube Turns Division of Chemetron Corporation are leaving the division's plants now under a new red-white-and-blue shipping tag bearing a prominent United States shield and the inscription "Made in U.S.A."

This is not just "flag-waving," said a Tube Turns spokesman, pointing out that clear identification of the country of origin, whatever it may be, is one step welding fittings manufacturers can take to help distributors and customers guard against the purchase of so-called "question mark" merchandise.

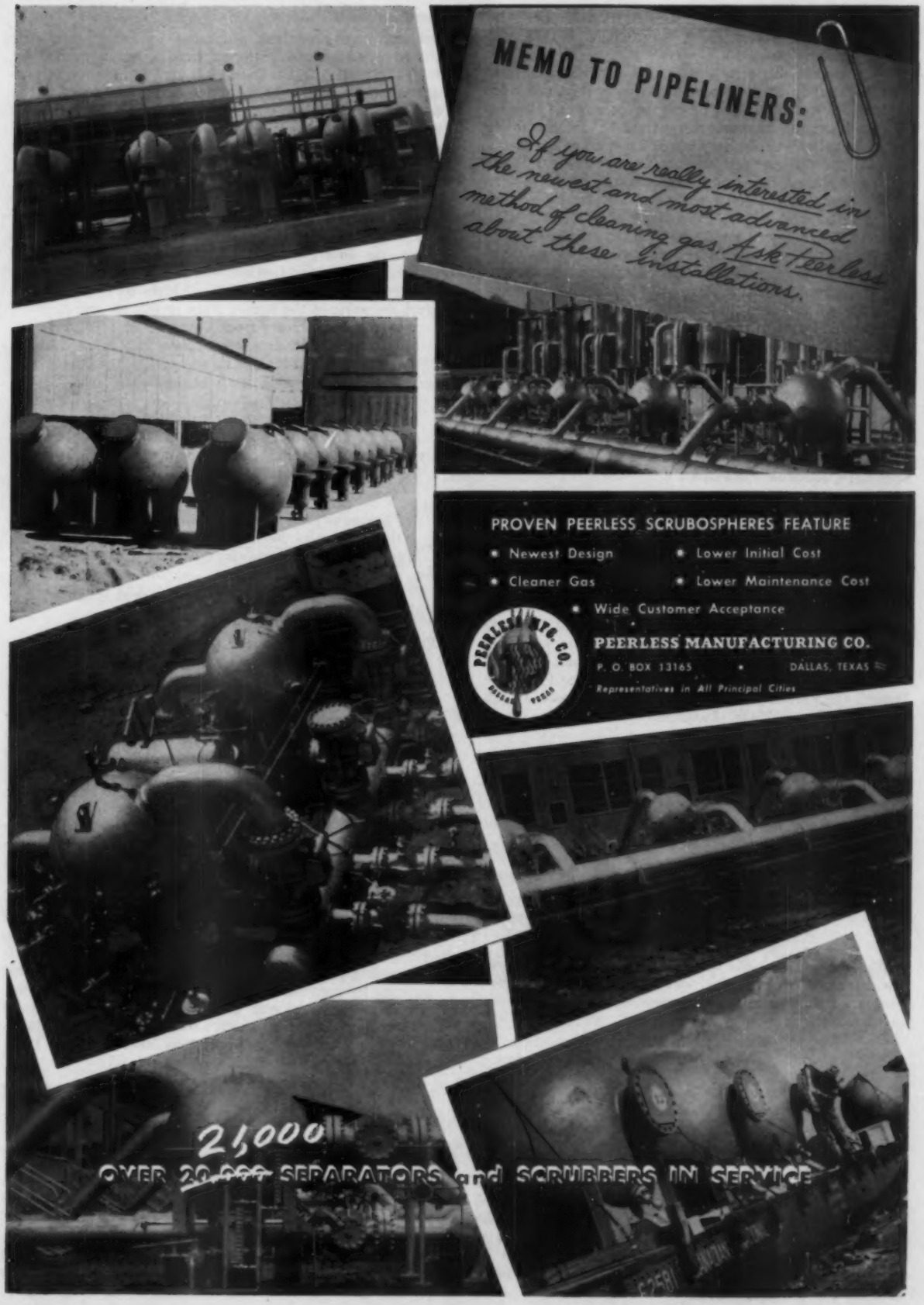
Convention Story

After the Democrat convention someone sent a wire to Senator Kennedy's father, "Dear Joe: You haven't lost a son you've gained a country."

IPAA President Explains Depletion

Alvin C. Hope, president of Independent Petroleum Association of America, recently gave a vivid example of what no depletion would mean to drilling and producing. Here is his illustration:

"Suppose I, as a wildcatter, purchased a lease for $1000 and drilled a well thereon. This well happens to be the tenth well in my wildcatting program—and remember only one well in 10 wildcats finds oil. This well discovers on this producing unit 100,000 bbl of oil. On a cost depletion basis


MEMO TO PIPELINERS:
If you are really interested in the newest and most advanced method of cleaning gas, Ask Peerless about these installations.
PROVEN PEERLESS SCRUBOSPHERES FEATURE
• Newest Design
• Lower Initial Cost
• Cleaner Gas
• Lower Maintenance Cost
• Wide Customer Acceptance
PEERLESS MANUFACTURING CO.
P. O. BOX 13165 • DALLAS, TEXAS
Representatives in All Principal Cities
21,000
OVER 20,000 SEPARATORS and SCRUBBERS IN SERVICE

I would be entitled to only one cent a barrel. Without applying the percentage factor, the balance would be subject to ordinary income taxes.

"Now suppose this acreage, being of increased value and close to already existing production, was purchased for $10,000. Subsequent drilling developed a reserve of 100,000 bbl. In this case, the purchaser would be entitled to 10 cents a barrel cost depletion. Continuing this line of reasoning, suppose the acreage was proven and the purchaser paid one hundred thousand dollars for the tract. He then would be entitled to a dollar per barrel cost depletion.

"I propose and emphatically claim that I, as a wildcatter, in this instance should be entitled to at least as much depletion as the big money investor. Certainly he has taken virtually no risk while I have indeed taken a tremendous risk. In addition to taking this risk, I literally have discovered and will put into the channels of commerce a commodity which next to food and clothing is the most necessary commodity to sustain our economy."

"If management surrenders its responsibility to manage, labor will lose its right to work." — John E. Swearingen, President, Standard Oil Company (Indiana).

Scientific Collection Presented TV

One result of the reorganization of Standard Oil (Indiana) was that the University of Tulsa is the first University in the nation to have a complete set of abstract cards on literature about the petroleum industry. The 350,000 card collection is one of two assembled by Standard's research scientists and will not be needed after consolidation. Made from 60,000 scientific articles published in the United States and abroad, the set covers in condensed form the most important developments in petroleum technology since 1930, according to Dr. Ben G. Henneke, president of TU.

Tulsa is the home of Pan American, Service Pipe Line, Indiana Oil Purchasing and Tuloma Gas Products, all subsidiaries of Standard Oil (Indiana).

Sometimes We Get Letters

I would like to express my appreciation for your editorial, The Giving Monument, which appears in the July 15 issue of Engineer. It is thought-provoking and at a time when our entire industry is under attack from so many directions, it issues a challenge to each of us to make our companies an even better place to work and to pass on to our successors.

J. R. Ashley, Manager,
Magnolia Pipe Line Company.

We wish to commend you on the vigorous editorial over the signature of Ernestine Adams in the August, 1960 edition of The Petroleum Engineer. *We would like very much to have reprints of this editorial.*

John J. Robertson,
Voss Petroleum Corporation

Coal Versus Oil in Germany

The long worked coal mines in West Germany are not exhausted but it requires very deep mining operations with the result that it is very expensive. West Germany can and does import American coal at less cost than it can mine its own. Recently Germany has had a sharp increase in oil consumption. There is pressure to replace coal all along the line with oil. Problem is the 150,000 miners who must be absorbed into the work force. Also most of this oil demand must be imported and war conditions might interrupt the supply.

Petrofina Adds Property

Natural gas-producing properties in Texas were purchased by American Petrofina from a group headed by John L. Loeb. A 225 million cu ft/day of natural gas production and a reserve of 32 billion cu ft were added to the company's properties. Since American Petrofina was formed in 1956 it has expanded rapidly into a $100 million company. Headed by Harry A. Jackson, it is a U. S. affiliate of the world-wide Petrofina group.

Wrong Way Record

The petroleum industry and its suppliers made progress in reverse on the stock market. *U. S. News and World Report* showed stocks of oil well machinery led all others in price declines from the 1958-60 highs to July 27, 1960. Here are some of the figures given in this survey:

Oil Well Machinery stock down	49.6%
Crude Oil Producers stock down	44.2%
International Oils stock down	29.4%
Domestic Oils stock down	27.4%
Gas Pipelines stock down	24.0%

All these stock dips were greater than bituminous coal companies. Their stocks were down 22.7%. In comparison cigarette manufacturers companies stocks went down only 1%, electric companies, only 3.2%.

"The most powerful and creative force on earth is the concept of freedom which imposes upon the individual responsibilities commensurate with the rights and privileges it guarantees to him."

— President Eisenhower.

Problems Shadow Economic Growth

As everybody knows statistics are what you make them, but we put a great deal of confidence into those that come out of the National Industrial Conference Board. "Economic Growth in the 1960's" presents a thorough study of national growth as measured in the past and estimates the prospects for the new decade. Impressive charts and brief copy go into the prerequisites, the potentials and the problems that the country will face and indicate what can be reached by 1970.

Some of the prospects: A gross national product as high as $800 billion; a total labor force of 87.3 million with unemployment about 4%; output per manhour to rise at 3.2% annually.

Three problems were mentioned in this decade: (1) readjustment of patterns of costs and prices, and of collective bargaining to attain a more stabilized monetary environment; (2) maintaining pace of agricultural revolution while minimizing subsidy costs; (3) defending our world trade position by controlling inflation and increasing deficiency.

Copies of "Economic Growth in the 1960's" may be obtained for $1.50 a copy from National Industrial Conference Board, 460 Park Avenue, New York 22, New York.

"One learns to itch where one can scratch." — Ernest Bramah.

Service Stations Get Bigger and Bigger

Have you noticed that service stations are growing? Now Midland Oil Company, distributor of Lion Oil products in St. Louis, has announced a 9280 sq ft service station and car wash building on a three-acre site in suburban St. Louis. The whole thing is going to cost more than a half a million dollars. In case you're in a hurry, there will be 16 gasoline dispensing pumps and five service bays.

Good Wells Make Good News

SEPTEMBER, 1960

A Report on Recent Fast Payout Acid Jobs

Here are four recent Dowell acidizing treatments that gave unusually fast payouts —increasing net profits to operators.

- **Midland County, West Texas** (New Gas Well) This Devonian well was completed through two sets of perforations between 11,456 and 11,542 feet. Production before treatment was only a small amount of distillate. Dowell injected 75,000 gallons of a special Retarded Acid, spearheaded by 3000 gallons Mud Acid. The Retarded Acid was injected at the high rate of 40 bpm and 5000 psi. After treatment, well tested 6800 mcfd with about 2000 barrels of distillate. Payout was unusually fast despite large size of treatment.

- **Chambers County, Southeast Texas** (Old Oil Well) This well had been completed through a screen liner between 5415 and 5449 feet. Production had declined to zero because of calcium carbonate deposits on the screen. Dowell used 500 gallons regular acid with a surfactant added. The acid was put on bottom and allowed to soak for 30 minutes; then it was squeezed into the pay. Production rose to 50 bopd. The $335.00 treatment paid out in about four days.

- **Ellis County, Kansas** (New Oil Well) This well gave no production before treatment. It had been completed through perforations into the Kansas City-Lansing between 3270 and 3281 feet. Dowell recommended 2000 gallons Retarded Acid (acid-oil emulsion type). A spearhead of 500 gallons regular acid with surface tension reducing agent was used. Treatment was down tubing at 2 bpm. After load was returned, well tested 14.65 boph — nearly three times that of similar offset wells. $881 treatment paid out in less than 15 days.

- **San Juan County, Utah** (Old Oil Well) Production had declined from an original 225 bopd to 34 bopd. Completion was in the Desert Creek zone of the Paradox at about 5600 feet. Previous treatments on similar wells in the area, using regular acid and high injection rates, had broken through to water or given unprofitable production increases. Dowell used 4000 gallons Retarded Acid spearheaded by 1000 gallons regular acid with addition agents to reduce surface tension and prevent emulsions. Injection rate was 5 bpm. Production rose to 450 bopd, and treatment costs were paid out in less than four days.

Anyway you look at it, the question is: "Can you afford not to take advantage of Dowell acidizing?" Get the facts from a Dowell representative. Chances are good that he can tailor an acid treatment to solve your production problem and increase your profits. Dowell services and products are offered from more than 150 offices and stations in the United States, Canada, Venezuela, Argentina and Germany. Dowell, Tulsa 1, Oklahoma.

Services for the oil industry DOWELL
DIVISION OF THE DOW CHEMICAL COMPANY

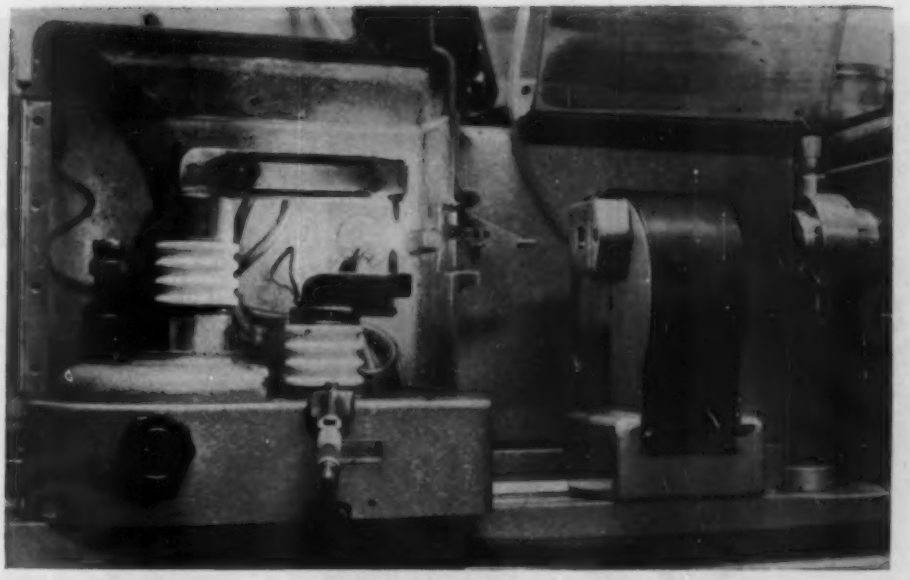
10,125 tests a day assure consistent quality in

GULF MAKES THINGS

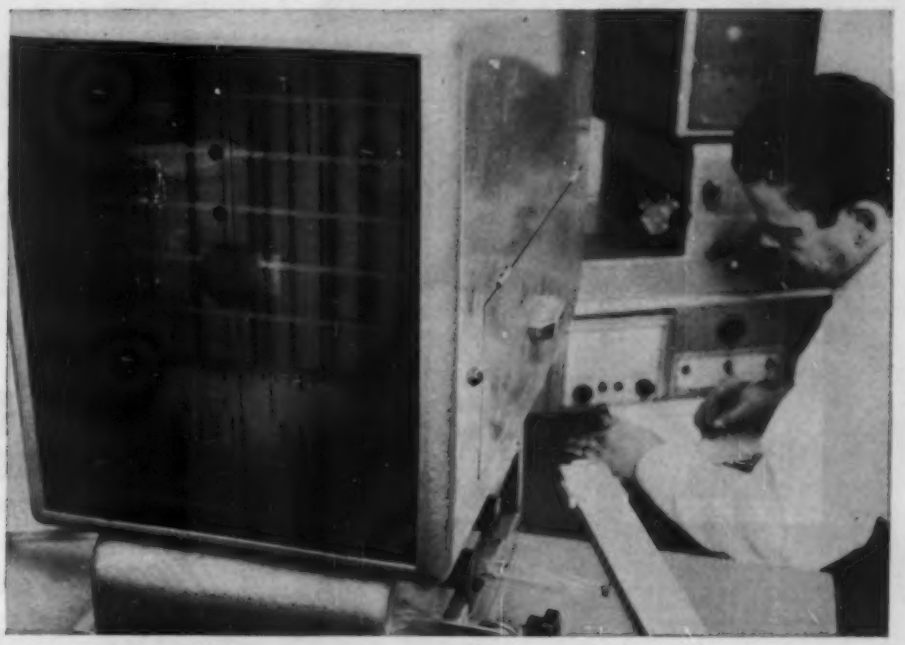
These bottles contain samples of a variety of Gulf fuels and lubricants. Each has been subjected to a series of quality control tests at Gulf laboratories. Any one of the tags shown might carry the "pedigree" of a Gulf product for a drilling rig or a pipeline pumping station.

Product purity is policed constantly at Gulf. During the refining process, samples from *every* lot of Gulf gasoline, diesel fuel, lubricating oil and grease are tested and re-tested to make sure that formulations are exact and that impurities are essentially eliminated. For ex-

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD



Emission Spectrograph (above) causes undesirable elements in a petroleum sample to emit their characteristic light spectrum which is photographed on a strip of film. In the Densitometer (below) the spectrum on the film is evaluated to identify the presence of metal contaminants down to less than one part per million.



every Gulf® product . . .

RUN BETTER!

ample, Gulfcrest® 44, world's leading turbine oil, is quality-controlled to limit contamination to less than one part per million.

A continuing program of quality control tests is one of the reasons we say: Gulf Makes Things Run Better!

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GULF®

Know it by the yellow handle

Use it because it embodies features never before combined in a needle throttling valve...

It is the first throttling and shut off valve that serves the whole range of pressures—from low to 10,000 psi—with equal efficiency all the way through.

It is the valve in which body and stem guide are one piece—completely fused into an integral leak-proof unit by the exclusive Marsh "Conoweld" process.

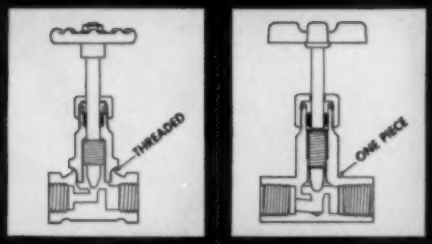
It is the valve in which the stem is precision machined and ground. Perfect stem alignment and fine threads provide easy and precise throttling. Special "Marpak" packing always holds tight; never binds.

Bodies of the 1900 series identified by the yellow handle are machined from high grade carbon steel bar stock marked in accordance with M.S.S. regulations showing size, material and service. Stems are 416 stainless steel. Valves are available in the patterns shown below; sizes ⅛", ¼", ⅜", ½", ¾" and 1".

Marsh Needle Valves are also available in 416 stainless steel throughout (identified by green handles). *Write for bulletins.*

MARSH INSTRUMENT COMPANY, Dept. H, Skokie, Ill.
Division of Colorado Oil and Gas Corporation
Marsh Instrument & Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alberta
Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas

In stock at your nearest Supply House



Conventional Construction | **Marsh Construction**

In conventional valve (left) stem-guide is threaded into body . . . can be backed out when valve is fully opened, causing real trouble when pressure is high. Can't happen with Marsh design (right). Marsh stem-guide is welded to body.

MARSH

SERIES 1900

Needle Valves

ACTUAL TESTS* PROVE

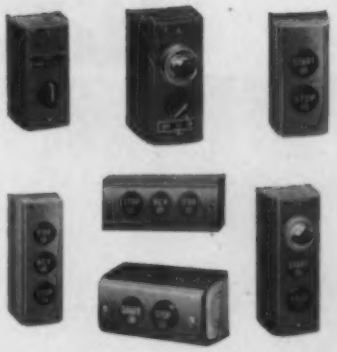
Allen-Bradley Standard Duty Push Buttons can be installed

in about half the time!

In accurately timed tests, Allen-Bradley standard duty push buttons required *about half the installation time*—on the average—than each of four other popular makes. This saving in installation time means "dollars" saved on the job. How come only the famous A-B standard duty push button possesses this time and moneysaving advantage? The answer lies in the molded, wrap-around cover—which also contains the contacts. When the cover is removed, the wiring terminals are *out in the open*—ready for wiring—and you have plenty of working space. The two cover screws are captive—they cannot fall out and get lost. And with the contacts in the cover, they are protected against accidental damage and careless wiring. Naturally, these push buttons have double break, silver contacts that never need service attention. There are two concentric knockouts on each end of the base, which are removed from the *outside*—the heavy, pressed steel base will not bend out of shape.

Your local A-B distributor has these Bulletin 800 push buttons *in stock*. Call him today—you'll save time and money on your next job.

**Using recognized standard duty push buttons, installations were made by an experienced electrician under identical conditions. He was not connected with Allen-Bradley Company in any manner.*

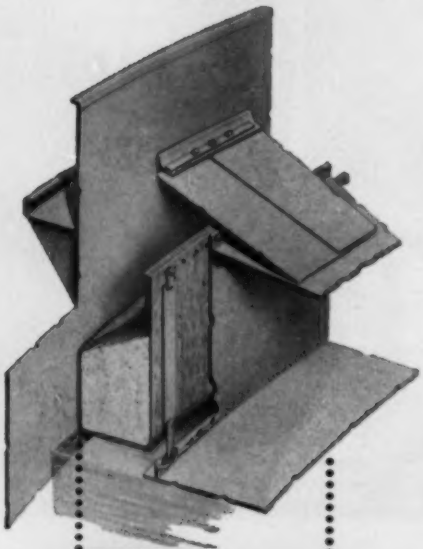


A-B STANDARD DUTY PUSH BUTTONS
Made as a one-, two-, or three-unit station—with pilot light available. Readily changed for horizontal or vertical mounting. Convertible two- or three-way selector switch supplied with or without pilot light.

ALLEN-BRADLEY
Member of NEMA

QUALITY MOTOR CONTROL

FIRST solid cushion seal



When General American developed EverSeal, first solid cushion seal for floating roofs, we wanted a seal that would have these advantages:

1. Simplicity of design, no moving parts, nothing to corrode
2. Permanent, indestructible sealing qualities—no gas or liquid to leak
3. Complete protection of coated tank walls from scuffing or gouging
4. A tough, pliable envelope that would withstand abrasion; ride without damage over projections on the shell
5. Ease of repair or replacement, without taking tank out of service
6. Maximum protection against evaporation loss
7. Full protection of oxygen-sensitive stocks
8. No build-up of vapors in the seal area

EverSeal is the *first* solid cushion seal to meet *all* these requirements. It is made of trapezoidal urethane foam cushions enclosed in a tough, scuff-proof envelope of Buna "N" synthetic rubber and polyvinyl chloride plastic.

EverSeal is almost impossible to damage, always provides a safe and complete seal for every floating roof.

Write or phone your nearest General American office for complete information.

It pays to plan with General American.

EverSeal*

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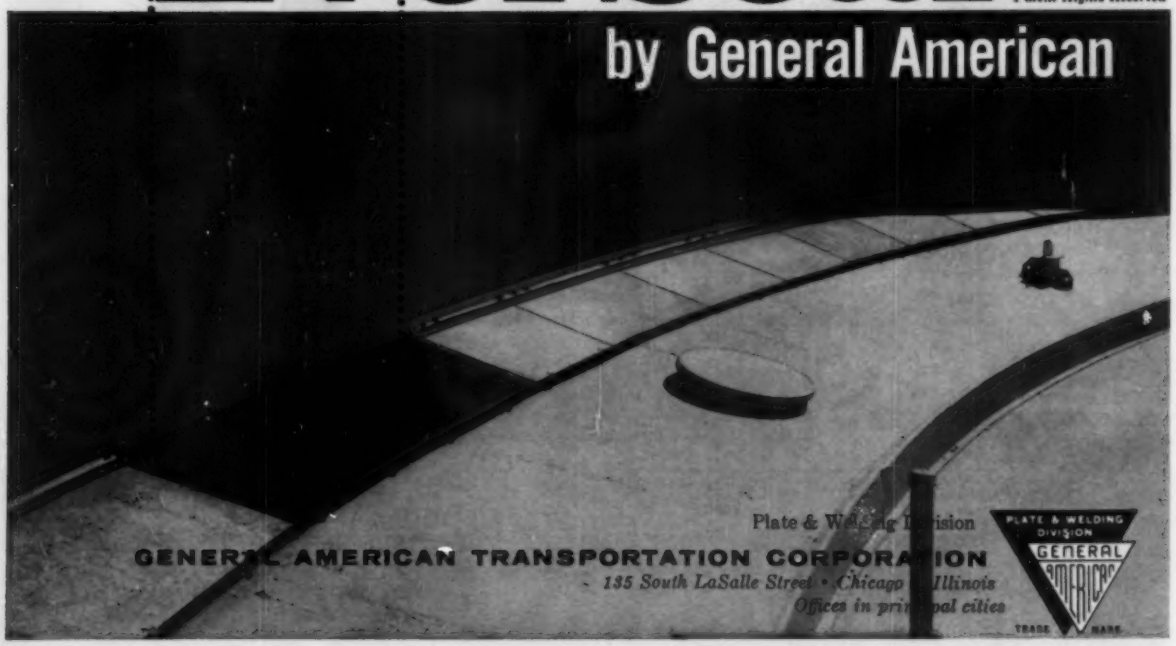

DAWN OF A NEW ERA IN INDUSTRIAL PROCESS CONTROL

introducing the first
computer system fully mated
to industrial process control....THE LIBRATROL 1000

Now for the first time your process control system can benefit from a transistorized digital computer totally designed for the modern industrial processing plant... the new, solid-state LIBRATROL*-1000. A distinguished new product of Librascope, manufacturer of the most varied line of computers in use today. Dozens of features make this the computer most likely to accelerate the current revolution in process control. **WHY THE LIBRATROL-1000 EXCELS AT INDUSTRIAL PROCESS CONTROL: PACKAGING FEATURES**...Sealed and refrigerated for long service life and reliability. Engineered for vibration resistance and ease of maintenance. **INPUT-OUTPUT FEATURES**...Quick-access loop speeds input of transducer data and output of commands to actuators. Numbers of transducers and actuators that can be accommodated are unlimited by hardware. **OTHER IMPORTANT FEATURES**...Sequencing is changeable by program. Complete random sequence, fixed sequence, or single channel. 8000-word memory. **ONLY LIBRASCOPE OFFERS CHOICE OF TWO COMPUTER SYSTEMS**...The LIBRATROL*-500 is a versatile but less expensive system... ideal for helping you develop a program of long-range conversion to automatic control... or for fully handling on-line situations not requiring all features of the LIBRATROL-1000. Either is available on a variety of purchase or lease arrangements. **CAN THE NEW ERA IN AUTOMATIC PROCESS CONTROL MEAN SIGNIFICANT IMPROVEMENTS IN YOUR COMPANY'S OPERATION?** *Find out. Write for the new Libratrol brochure with specifications and operating information. Or better still, request consultation now with a Librascope Systems Engineer versed in the control requirements of your industry.*

*TRADEMARK, GENERAL PRECISION, INC.

LIBRASCOPE DIVISION **GENERAL PRECISION, INC.**
Glendale 1, California

Computers that pace man's expanding mind

NEAR PERRIN, TEXAS

D6B MOVES EARTH FASTER—preferred by oil company

Owner Willie M. Mitchell keeps his D6B busy the year around. In addition to oil field jobs, he handles soil conservation work. A long-time user of Cat equipment, he says the new D6 is tops whatever the task.

"It's the best!" That's how owner Willie M. Mitchell described his new Cat D6B Tractor at a site preparation job 5 miles east of Perrin, Texas. "I'm moving dirt faster and easier than with my previous D6 and maintenance time is cut in half—the oil company I do work for wants Cat equipment on the job. They know they are getting more work for the hours they pay for."

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WHERE RESEARCH TODAY MEANS PROGRESS TOMORROW

BUSINESS DETECTIVES WOULD STALK INFORMATION

New Profession to Aid Management Proposed

WHEN MARION HARPER, JR., president and chairman of the board of McCann-Erickson Inc., was presented the Charles Coolidge Parlin Award he launched the idea of research generalists for decision-making. His concept is an interesting innovation which may be taken up sooner than we think.

MARION HARPER, JR.

MY FIRST PREMISE is this:

1. *To manage a business well is to manage its future; and to manage the future is to manage information.*

A good manager today can afford little time with the present and still less with the past. His concern must be for the future growth and success of the business or institution in his charge. He must make decisions every day, every hour, every minute — decisions affecting the future, and to some degree involving forecasts. We who have responsibility for decisions — whether in business, government, or wherever — hope that they are right decisions. But we seldom know. One of our troubles, or should I say blessings, is that the consequences of most decisions remain obscure — and short of going into bankruptcy, we hardly ever find out how bad our decisions sometimes are.

We can never have all the facts to cover all contingencies in a forecast. A decision to act or not to act must always be partly rational and partly visceral. There will always be a last step involving personal courage, personal commitment, and personal responsibility.

In modern business, however, reliance on facts has reached proportions of a virtual explosion of research. Research and development investment is now at the level of $9 billion and may rise to $18 billion over the next 10 years. We can consider this expenditure as investment in management decision-making — to help determine the future environment for a particular course of action, or to indicate the superiority of one course of action over another.

A RELATED PREMISE is this:

2. *The term "informed decision" is a relative one.*

We use the expression almost as if there were two kinds of decisions — informed and uninformed — but obviously there are many different kinds of decisions, involving different proportions of information.

No decision is wholly informed or wholly intuitive. By definition, any decision involving unknowns is a speculation. Business competition will always involve some poker strategy, but, thanks to research, a manager can sometimes assess other hands at the table and predict the next play.

ANOTHER PREMISE which we can all accept:

3. *Management decision-making is becoming an increasingly complex process, with a multiplication of both knowns and unknowns.*

Take one example: Not many years ago, the problem of locating a plant was a matter of checking on shipping facilities, raw materials, and available labor supply. Now it's the subject of a whole catalog of factors and special studies. On the other hand, there are problems for which procedures or research data are not available. For these, management makes — or fails to make — judgments in virgin territory.

To mention a recent example: A congressional committee was asked to appropriate funds for an atomic accelerator. The decision turned on whether to build a proton or an electron accelerator. I am told that if you had asked ten atomic scientists, five would have favored one kind and five another. In this instance, the Democratic committee members favored the electron, and the Republicans, the proton. The issue was resolved — as issues sometimes are — by postponement. Neither electron nor proton could muster enough political strength to win the day.

The problems of management are less esoteric and usually can be illuminated with some help from research. But, in general, it is true that good solutions depend on a large number of factors and on information-gathering from many different fields.

MY NEXT PREMISE is this:

4. *We are entering upon an Information Revolution in which the supply of data increases by geometric progression.*

The most successful decision-makers will be those who can best process, interpret, and put facts to use.

One of today's data-processing machines can read or write at the rate of four full-length novels a second; its 640 cartridges hold 220 miles of magnetic tape. Machines such as this will be fed by a growing corps of government, business, and scientific researchers, stimulated by today's greater appetite for knowledge.

Production of the sheer mass of information will increase at a far higher rate than our Gross National Product or any other production growth.

The key question, then, is — how well will we use this mass of raw information?

If a little learning is a dangerous thing, too much — that is, knowledge not put to good use — can be a costly waste. Like the raw materials of industry, information must be *converted* into something.

ANOTHER PREMISE:

5. *As information multiplies, management needs "protection" from the specialist.*

By the nature of his work, a manager is a generalist. He

must, of course, have access to the knowledge and ideas of specialists to arrive at solutions to serve his company's goals.

Specialists are indispensable but they have their shortcomings. The specialist in the social sciences contributes best when his proposals are reviewed by a generalist. I think the reason is that in the social sciences, hardly anything is absolutely certain *except the things we know anyway without the benefit of research.*

It is essential for specialists to report to a senior arbiter or interpreter. In the past, management has usually assumed this task and will always hold final responsibility; but it would be more appropriate for this function to be assigned to a research generalist who would be an adviser to management.

To fulfill such a coordinating role, a man must know what the various specialties are about. It is not necessary that he achieve the same competence as the specialist, but he should have a thorough understanding of each field.

THE LAST PREMISE IS:

6. *Too many people take part in decisions — and too many decision-makers use the wrong tools.*

One reason for calling meetings is probably an impulse to assemble anyone who knows anything about the problem; so that people are brought in for their basic information — not necessarily for their abilities to deliberate.

Very often, their information might be quite as well gathered and summarized by an able reporter, and fewer people would be required to pass upon the problem.

Another poor device for decision-making is the office routing system. Too many problems are forced *upward* through an organization — with the result that there is a misplacement of decision-making.

The failure to direct usable data where the decision should be made also aggravates a fault of all levels of management — a reluctance to make decisions. It is unlikely that we can change human nature overnight to develop a more courageous breed of executive; but we can support whatever courage there is with risk-reducing facts.

There is also too great a reliance on obsolete information that often goes under the venerable name of Experience. The world today changes at such an accelerated speed that if you make a decision for 1963 or 1967 on the basis of your experience in 1953 or 1960, it may prove costly.

Today's research must not only be up-to-date, but must develop techniques for forecasting facts for the future.

Still another fault is that too much decision-making is on an instant or *ad hoc* basis. This is sometimes unavoidable but the result is decision-making that seldom has the benefit of current information.

Management decision-making is a continuous process. It is desirable that it be supported by a continuous program of research.

If you ask a manager how many of the decisions he made in the last year affected the development of his company, he may say not more than five, or at the most, ten. If the manager tries to *anticipate* the five or ten really critical decisions which he will be called upon to make during any succeeding year, he can then initiate a series of research projects which will facilitate and improve these decisions.

I HAVE ATTEMPTED in this recitation of premises to suggest that the need for processed information to help manage our future is now vastly increased. But my larger purpose has been to sketch in a background for the following proposal:

We should encourage the development of a new profession to provide an intelligence service for the shaping of strategy and policy.

Such a profession would rise out of the fine record of all the technical achievements of research up to the present, and it would strive for a still higher stature. A member, through special training comparable with that of other professions and through proved capability, would occupy a post of "Director of Intelligence Services."

Management would look to the Director of Intelligence Services as someone who would develop information for alternative recommendations and who would outline the probable consequences of moving in any direction. He would not invent policy — although he might — but he would measure and help shape it.

The function I have in mind is sometimes carried on by forward planning departments, but usually their executives do not have the broad technical background which can link the all-important fact to the all-important policy.

What is needed is a professional school — very much like a law school, medical school, or engineering school — which could launch young men and women on a highly rewarding career — a career which could place them at the exciting nerve centers of business and bring them into the highest counsels of management.

The object of such schooling would be to give students at least a working familiarity with business operations, and the basic knowledge required for planning and executing a broad-gage research program. It would indoctrinate young men and women in the business of problem-solving through the management of information. The chief executive would still practice the *art* of problem-solving; but the aspirant intelligence director would learn what can be learned about the *science* of problem-solving.

Today, we know fairly well the technical skills required for a good intelligence director. Actually, they are already being taught in a number of universities, and some are taught very well. But, usually, you find them not only in different departments but in different schools. Even if they are all available under the roof of one university, there is no provision for a student to train in a single curriculum.

What might such a curriculum include? I would say — *survey techniques* — currently taught well in only a few places . . . *statistics* — indispensable to the modern researcher, and given usually in a statistics, mathematics, or psychology department . . . *econometrics* — in economics departments . . . *projective psychological research* (which goes under the name of motivational research) — taught in psychology departments . . . *the theory and practice of experimentation* — found in the department of industrial engineering or, sometimes, in the statistics department — and *operations research,* also in industrial engineering.

Other courses for a research generalist might include *computing-machine techniques . . . analysis of administrative data* — such as data compiled by the Census or by industrial trade associations . . . and related study in *library technique.* And finally, to complete such an intelligence curriculum, the *design and management of research* — that is, the managerial supervision of research.

I am happy to pledge, on behalf of McCann-Erickson, a fund of $50,000 to establish at one interested university a program of studies leading to a graduate degree in research. We hope that others will want to add to this fund — to develop a curriculum and teaching materials and to extend such a program to other universities.

We hope that one source of support will come from companies wishing to send their own research people for courses in latest techniques. This could be a rewarding service for all participating — inasmuch as business research, like all young disciplines, makes fast headway; research men who stopped learning even as much as three years ago may be lagging in their skills today.

I believe there could be few undertakings that might contribute as much, both in everyday business efficiency at home, and economic vigor abroad, as the training of people who can identify and shape the building blocks of our major decisions. ★ ★ ★

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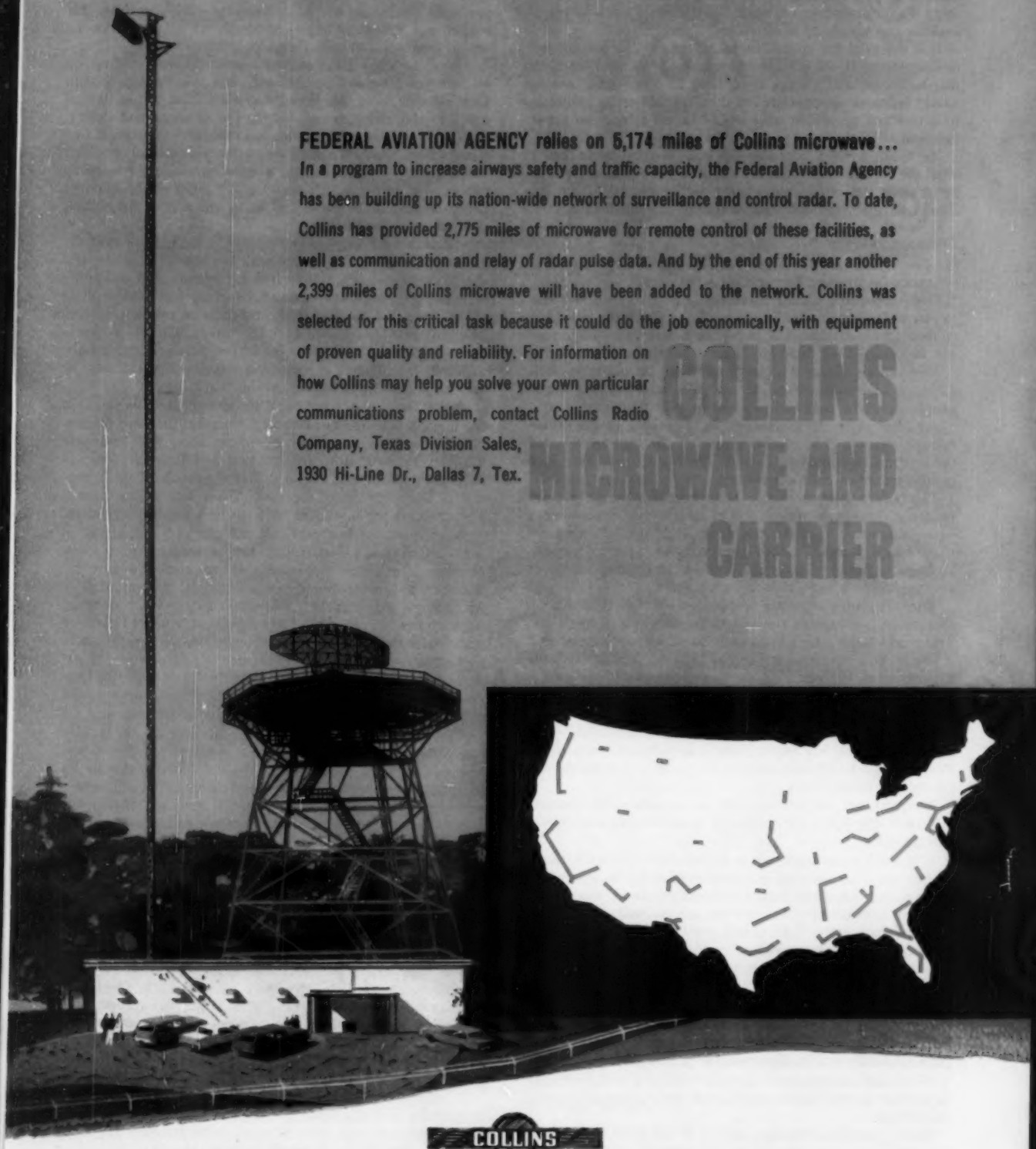

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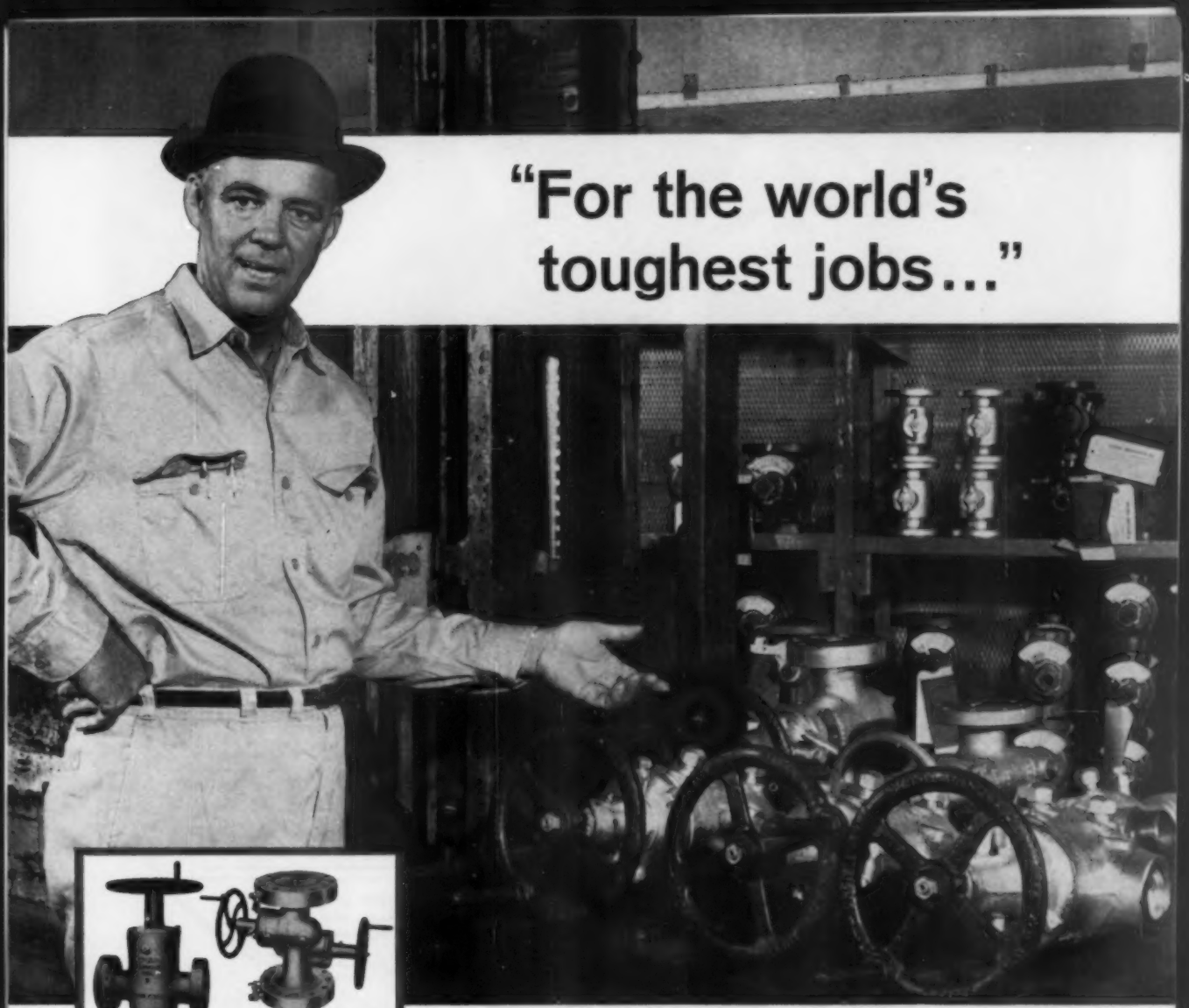

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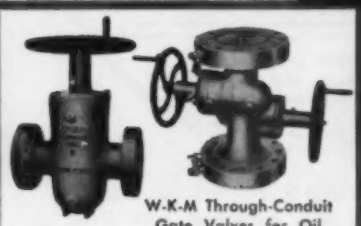

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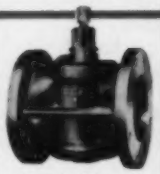

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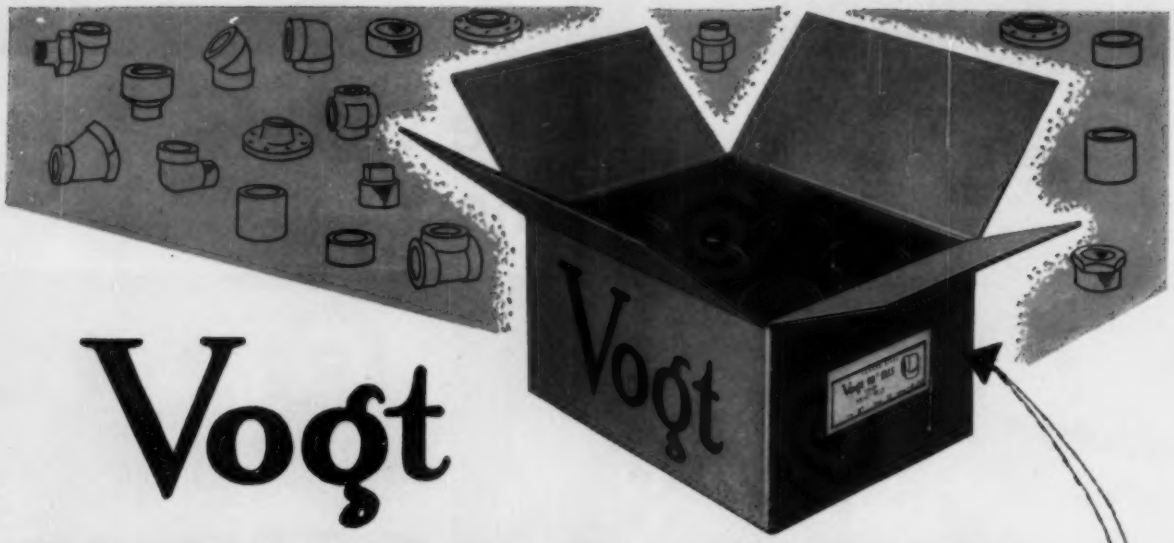

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Aerial view of Cartagena refinery.

SPAIN SEEKS BIGGER ROLE IN PETROLEUM

Eduardo Recasens

Tempo rises in exploration and plant expansion since new oil code opened door to private capital

SPAIN IN 1958 attacked its burden of oil purchases forthrightly. It revised its laws to attract capital and provide its own production.

In the 20 years since the end of the Spanish Civil War the national economy found the outlay for petroleum increasing. Today the nation pays out $120,000,000 annually for crude oil and oil products imports. Greater use of energy was encouraging but a burden on exchange.

Inspired by petroleum discoveries in France, Italy and French Sahara, the

MAP 1. SPAIN AND SPANISH TERRITORIES IN THE WORLD

	Area, sq miles	Population
Continental Spain	195,504	29,431,000
Balearic Islands	1,936	433,000
Canary Islands	2,808	697,000
Spanish Sahara	120,000	32,000
Spanish Guinea	10,852	212,000
Total	331,100	30,805,000

Government decided Spain and its territories may have a similar potential. The first step was to revise the laws to bring in outside companies.

This meant a complete change of position from the one held in 1952 when a State National Reserve for exploration and drilling in all Spanish Territories, not previously licensed to others, was established by law. The Government enterprise, Instituto Nacional de Industria (INI) was officially commissioned to explore and drill in the State Reserve covering the Spanish Sahara and Guinea, among other Spanish territories.

When this policy was rescinded and new legislation passed December 26, 1958, it aroused keen interest not only in Spain but internationally. As a result, more than 20 companies (Spanish and foreign) have been awarded concessions in Continental Spain, Spanish Sahara and Spanish Guinea.

Map 1 shows the location of Spain and its territories. Of the old Spanish Morocco only the cities of Ceuta and Melilla have remained Spanish whereas the rest of the land has been integrated in the newly-formed Morocco nation. The Canary Islands have been provinces of Spain for centuries; the Spanish Sahara and the Spanish Guinea have in the course of 1959 been incorporated into new provinces of Spain in lieu of being just possessions.

Law Is 50:50 System

Zones. The new "Hydrocarbon Law" sets out three zones of the Spanish territories:

Zone I. Continental or Peninsular Spain, Balearic and Canary Islands, and North African Territories (cities of Ceuta and Melilla and small surrounding areas). In this zone each investigation permit will have from 10,000 to 40,000 hectares.* Maximum number of permits to each operator is 20 with a total area of 800,000 hectares.

Zone II. Covers the Spanish Territories of Guinea (provinces of Rio Muni in the African Continent and the Island of Fernando Poo). For this zone each permit or block covers a surface of about 68,500 hectares and no petitioner can hold more than 4 permits.

Zone III. Covers the Spanish African occidental territories (provinces of Ifni and Sahara). Permits have approximately 253,000 hectares. Up to a total of 16 permits can be awarded to each petitioner.

Stages. Here are rules for progressive work:

Surface exploration is entirely free and non-exclusive.

Exploration permits cover 6 years in Zones I and III and 8 years in Zone II. A further 3 years extension can be obtained after reduction of the original surface of 25% in Zone I, and 50% in Zones II and III. Another extension of 2 years can be obtained in Zone I in special cases after a further 25% surface reduction. In very exceptional cases, with no further reduction in surface, a last extension of 3 years can be awarded in return for fulfillment of certain conditions.

Exploitation concessions are awarded thus: In Zone I one exploitation concession for each exploration permit of 10,000 hectares surface, two for each permit of 20,000 hectares, etc.; Zone II one exploitation concession for each 5000 hectares of exploration permit; Zone III one exploitation concession for each exploration permit of 125,000 hectares.

Total exploitation concessions cannot exceed 50% of the original area in any one of the three Zones, so a minimum of 50% goes back to National Reserve.

The Cabinet of Ministers grants concessions by decree. These can confer the right to store, refine, transport and sell in Spain or export the products, subject to the law.

Fiscal provisions. The new Hydrocarbon Law has introduced for the first time in Spain the 50:50 system. Taxes on gross production (13.5% in Zone I and 12.5% in Zones II and III) and several other expenses are deducted before the 50% payment. These include certain taxes, loss of property, amortization, variation in money exchange rate, and depletion.

State Reserves. In Zone I a State Reserve of 3,500,000 hectares was set aside for INI to carry out exploration and ask for exploitation concessions as desired. Also relinquished areas will add to the State Reserve. In Zone II and III these Special Reserves will be kept in favor of the State.

Other stipulations of the Law include:

a. Grants can be made to any Spanish or foreign concern with sufficient technical knowledge and financial backing as accepted by the Spanish Administration. In principle, there is no limitation when considering the nationality

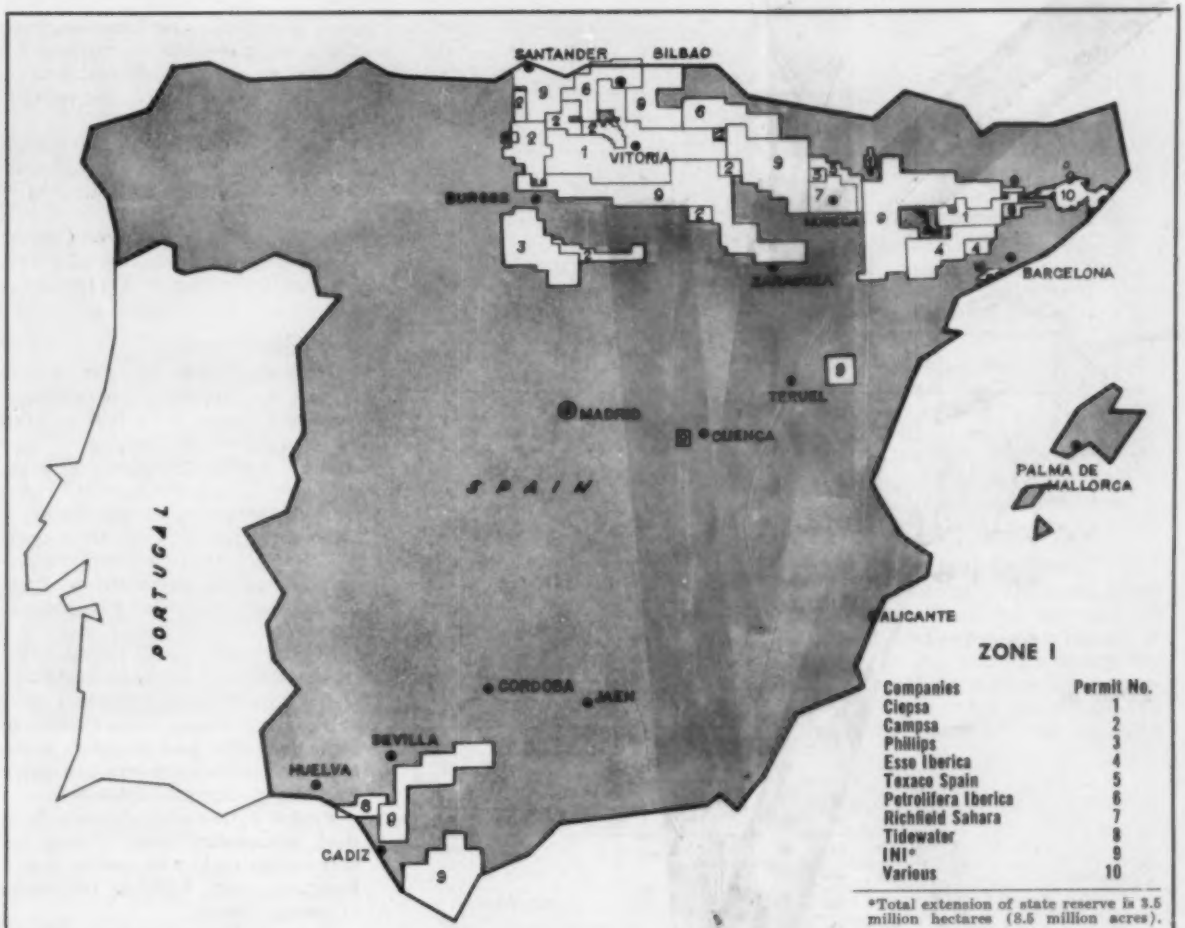
*A hectare = 2.47 acres.

Retroactive Terms Baffling

Red tape grows when new laws are being worked out and Spain has a big crop. Some terms have been imposed after concessions were awarded that apparently have little basis in the law itself.

Several oil men who have been on the scene report that General Franco has been requested to set up a single government body to handle the innumerable problems that arise in implementing the Petroleum Law. At present there are four or five bureaus involved. There is some friction among them on where specific authority lies and companies are uncertain about where to get government approval on operations. The sooner this area of confusion is cleared up, the sooner Spain and its territories will reap the benefit of efficient petroleum development.

The Editor



MAP 2. EXPLORATION PERMITS IN CONTINENTAL SPAIN

of the applicant although outsiders must organize a Spanish company or a company with an official address in Spain before presenting any application for permits and concessions. Exceptions are intermediaries and firms owned and controlled by foreign governments.

b. When several applications for the same areas are presented, the law establishes that preference should be given to the first applicant if other conditions are equivalent. In case of different conditions, the Administration will make the selection. This may leave room for manipulation if the officials were inclined, but so far the process seems to work very well.

c. In case of production, the holder of each concession is obliged to supply crude petroleum and petroleum products, gases and derivatives, which are required for national consumption in proportion to production. Supplies will be paid in pesetas,* at prices based on international trade plus transportation costs to Spanish ports.

d. The owner of a concession can export freely without limitation the excess production over the quantity he is obliged to supply for national consumption.

e. When the value in pesetas of petroleum exceeds the amount in pesetas required to pay the expenses and investments in the concessions, the excess can be converted into foreign currency without limitation when the capital of the owner is 100% foreign and up to the limit of foreign percentage participation if the owner capital is mixed.

*A peseta = approximately $0.17.

TABLE 1. Concessions on Mainland

Companies	No. permits	Area, hectares
Campsa	5	230,086
Ciepsa	11	261,986
Compania Petrolifera Iberica	11	334,908
Epessa (Calspain and Texspain)	5	119,957
Esso Iberica	8	315,366
Tidewater	4	75,783
Richfield-Cities Service	3	97,187
Phillips	13	441,130
*Campsa	12	451,458
*Ciepsa	21	893,650
*Compania Petrolifera Iberica	16	424,353

*Permits held previously and converted.

Exploration Permits Awarded

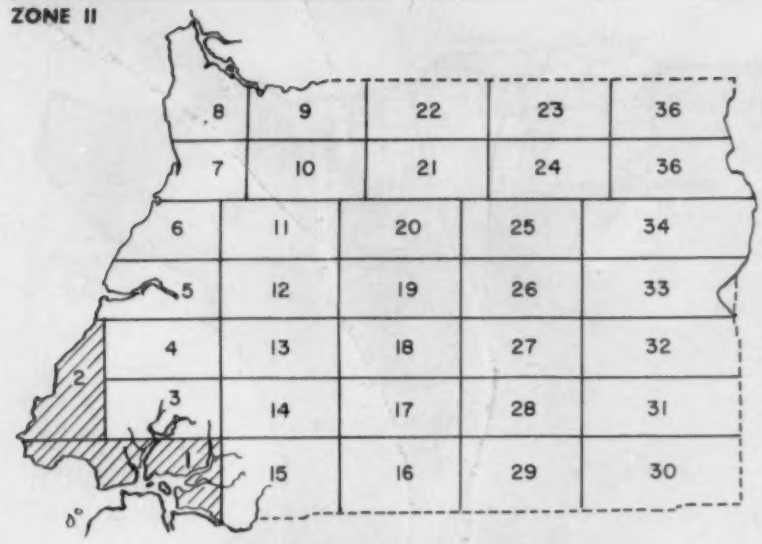
After the new Law, Zone I concessions were awarded as shown in Table 1.

After the new Law several minor groups continue to hold small extension permits. The State Reserve assigned to INI and subsidiaries has been reduced to the maximum of 3,500,000 hectares in peninsular Spain as provided in the Law. Map 2 shows areas over which permits have been granted.

In Zone II only Spanish Gulf and Cepsa have asked for and obtained permits (See Map 3). These two are blocks No. 1 and No. 2 with a total surface of 116,618 hectares.

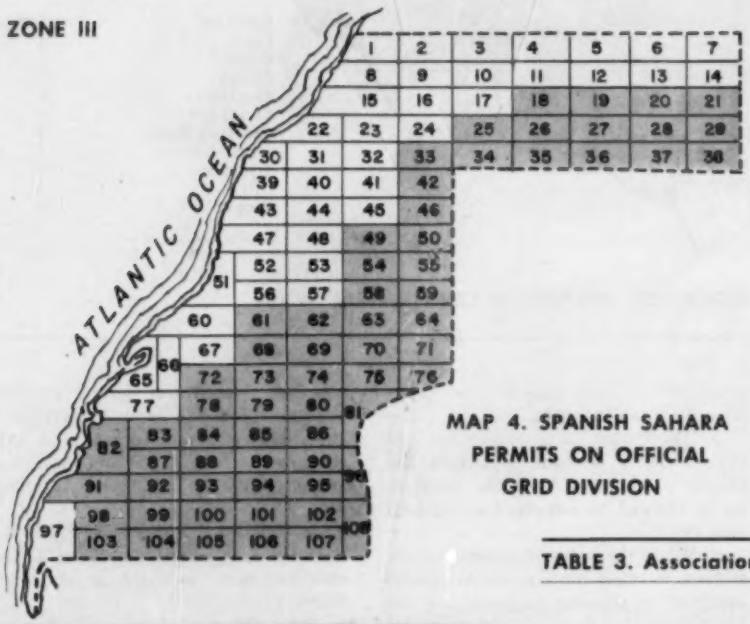
In Zone III (Map 4), permits awarded are shown in Table 2.

Only permit now applied for in Zone III is: in block 33 with 246,231 hec-



MAP 3. SPANISH GUINEA PERMITS ON OFFICIAL GRID DIVISION

Permits 1 and 2 — Cepsa & Spanish Gulf — 116,618 hectares



MAP 4. SPANISH SAHARA PERMITS ON OFFICIAL GRID DIVISION

TABLE 2. Concessions in Spanish Sahara

Companies	No. permits	Blocks	Area, hectares
Union of Calif. & Iber. Petroleos	3	1, 2, 8	703,250
Champlin-Pure-Sun & Iberica	2	15, 23	557,523
Epessa (Calspain* & Texspain*)	6	22, 31, 32, 41, 45, 57	1,457,766
Campsa, Banesto, Richfield, Cities Service	4	30, 39, 40, 43	899,931
Standard of Ohio (Sohio)	5	48, 52, 53, 56, 60	1,232,965
Tidewater Oil	4	7, 13, 14, 24	977,039
Cepsa & Spangoc (Gulf)	5	9, 10, 16, 47, 51 3, 65, 66, 97	2,163,791
Phillips	2	4, 11	487,433
INI & Pan American	2	5, 6	486,700
INI & General American	2	17, 44	492,430
Atlantic Exploration	3	12, 67, 77	804,355

*California Oil Company of Spain and Texaco (Spain) Inc.

tares, both Iberica de Petroleos, S.A., and a company called Magellan are seeking. Recently Cepsa and Spangoc were granted four blocks and Atlantic two.

Associations of national and foreign companies for Zone III have officially been established and are described in Table 3.

It is expected that in 1960 Campsa will establish an association with Texspain and Calspain to drill in peninsular Spain.

Geological Survey

Continental Spain. Map 5 shows continental Spain divided into regions of petroleum interest. Areas with diagonal lines represent unfavorable regions. Here are brief descriptions:

Region 1. Astur-Pirenees. Favorable sedimentary formations, but because of complicated tectonics interest is slack.

Region 2. Astur-Hercinian. Important sedimentary formations but irregular and abrupt tectonics have reduced interest.

Region 3. Old Castile Plateau. Thin sedimentary series of porous rocks with sealing covers. Under a Miocene cover of medium thickness — the Cretaceous formations offer good prospects in this region but probably in very thin layers. Requires geophysical exploration.

Region 4. Cantabric Pirenees. Very thick sedimentary series. Porous and very porous rocks with sealing covers. Frequent shows. Uniform formations of general interest.

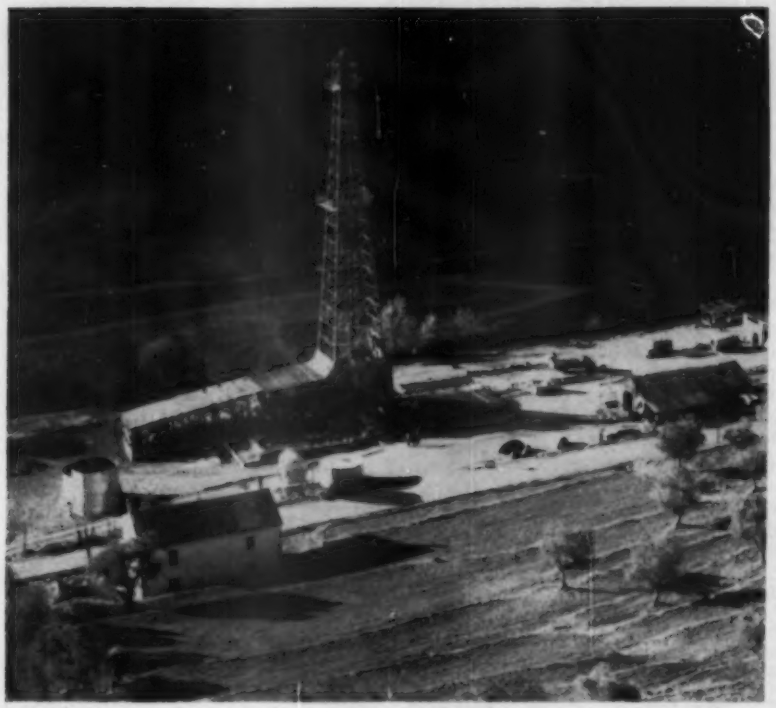
Region 5. Iberian. Medium sedimentary series. Very porous rocks and sealing covers. Few shows but some of great interest. Irregular distribution. In general the stratigraphic formation is ideal as oil reservoir although in certain parts the layers are too thin.

Region 6. Pirenees. Thick and medium sedimentary series. Porous rocks with sealing cover. Complex to simple tectonics. Frequent shows. A great

TABLE 3. Associations of Spanish and Foreign Companies

Spanish companies	Foreign associations	Spanish participation: Investig. expenses %	Spanish participation: Production benefits %	Foreign participation: Investig. expenses %	Foreign participation: Production benefits %
Iberica de Petroleos, S.A.	Union Oil	0	30	100	70
Iberica de Petroleos, S.A.	Champlin-Pure-Sun	0	25	100	75
Instituto Nacional de Industria	Texspain & Calspain	40	40	60	60
Campsa & Banesto	Richfield & Cities Serv.	15	20	85	80
Banco Urquijo	Sohio	40	20	60	80
Cepsa	Spangoc (Gulf)	0	50	100	50
	Phillips			100	100
I N I	Pan American	25	50	75	50
I N I	General American	25	50	75	50
	Atlantic			100	100
Cepsa*	Gulf	50	50	50	50

*In Spanish Guinea.



Ciepsa drilling rig in Province of Huesca.

variety of conditions leads to varying interest.

Region 7. Ebro Valley. Very thick sedimentary series, adequate rocks probably under the Oligocene cover. Simple tectonics. Shows are unknown. A filling of continental Oligocene, which does not have petroleum but can receive it from deeper layers. Its great thickness is a disadvantage. Lower and older formations of great tectonic interest lay very deep.

Region 8. Catalan Coast. Thin sedimentary series. Porous rocks with sealing cover. Tectonic medium to complex. Few shows, but some very important ones. Very irregular distribution.

Region 9. New Castile Plateau. Thin sedimentary series. Porous rocks with sealing covers. Medium to simple tectonics. Doubtful shows. Cretaceous under a Miocene cover possibly with petroleum formations.

Region 10. Antibetic. Medium to thin sedimentary series. Rocks not very adequate. Simple to abrupt and irregular tectonics. Some shows. Irregular distribution. The region is complicated and difficult to study systematically.

Region 11. Betic chains. Thick sedimentary series. Great variety of rocks; some adequate. Complex tectonics. Frequent shows. The region is so complex it is difficult to make a systematic study. Difficult to evaluate.

Region 12. Guadalquivir Valley. Medium and thick sedimentary series. Rocks frequently adequate. Very irregular tectonics. Frequent shows. Complex and difficult to evaluate.

The Spanish Sahara. Only surface exploration was permitted by the Government in the Spanish Sahara prior to awarding permits so the information available or published is scarce. Interest of the applicants was concentrated in the north and recently in the coastal center and south. Geophysical survey and also exploration drilling is about to start.

The Spanish Guinea. Only the continental coastal seabed and close offshore islands seem to offer an interest. Some surface exploration work has been carried out by Cepsa and Gulf. It is expected to find formations similar to those in Gabon where petroleum is produced.

Prospecting and Drilling

The first wildcat in Spain was drilled in 1900 at Huidobro (province of Burgos). The well was abandoned at 1600 ft. In 1920 the State through the Geological Institute commenced to investigate the subject, and carried out prospecting and drilling for oil. Then

MAP 5. GEOLOGICAL ZONES OF IBERIAN PENINSULA (SPAIN AND PORTUGAL)

Zone No.	Name	Area, sq. km.
0	Cristal Hercinian Nuclei	201,203
1	Astur-Pirenees	4,012
2	Astur-Hercinian	8,024
3	Old Castile-Plateau	34,052
4	Cantabric Pirenees	22,046
5	Iberian	52,156
6	Pirenees	14,042
7	Ebro Valley	35,055
8	Catalan Coast	6,220
9	New Castile Plateau	38,078
10	Antibetic	20,060
11	Betic Chains	42,527
12	Guadalquivir Valley	14,042

1 sq. km. = 0.3861 sq. miles

in 1927 the State Monopoly on petroleum and products was set up, called Campsa (Compania Arrendataria del Monopolio de Petroleos, S.A.). A year later a Spanish 100% private and independent petroleum company was founded—Cepsa (Compania Espanola de Petroleos, S.A.). (Later constructed the Teneriffe Refinery.)

Both Campsa and Cepsa made new efforts to explore and drill in Spain, but until 1936 total number of wells drilled by the State, private companies and individuals was 19. Among them, 3 were over 3000 ft and one reached 5450 ft in Gastiain (Navarra) and had gas shows. The majority were drilled to 2000-2300 ft. Nine had gas or shows but no commercial production.

During the Civil War three wells

were spudded in but never completed. One was continued after the war to 5600 ft at Tremp (province of Lerida) after drilling into asphaltic residues.

When the Civil War ended in 1939 searching for oil was resumed with greater vigor. In 1940 Cepsa and Socony (50-50) founded Ciepsa (Compania de Investigacion y Explotaciones Petroliferas) as an oil prospecting firm. Some exploratory work was done but, because of the World War, drilling had to be delayed until 1947 when a new American rig could finally be imported.

In 1950 Socony relinquished its interest in Ciepsa and a German firm, C. Deilmann Bergbau, decided to participate.

The government enterprise INI was organized in 1952 and the following year Valdebro was incorporated by the INI subsidiary, Adaro, and a group of American companies (including General American Oil Company, DeGolyer and MacNaughton and Caltex.)

Table 4, with wells completed since 1941 and those still drilling, shows Valdebro a leading explorer with 26 wells listed. One completed in 1960, Monesma No. 1, Huesca province, has a total depth of 15,584 ft. Deepest well in Ciepsa's Alda No. 1, at 16,503 ft.

The table is not complete. Shallow

TABLE 4. Wells Drilled on Spanish Mainland Since 1941

Well	Province	Company	Completed	T. D. ft	Results
1. Tudanca	Burgos	Campsa	1941	1,460	Dry.
2. Zamanzas 1	Burgos	Campsa	1942	2,000	Traces oil & gas.
3. Zamanzas 2	Burgos	Campsa	1944	2,700	Oil & gas shows.
4. Zamansas 3	Burgos	Campsa	1945	2,800	Gas & oil shows various levels.
5. Oliana	Lerida	Ciepsa	1948	7,300	Eocene. Dry.
6. Chiciana 1	Cadiz	Adaro (INI)	1947	2,450	Miocene limestone. Oil shows 675 ft.
7. Pena Ortun	Burgos	Campsa	1950	4,150	Oil & gas shows.
8. Burgo de Osma	Soria	Ciepsa	1950	7,253	Dry.
9. La Marina	Alicante	Ciepsa	1951	5,300	Dry.
10. Dobro	Burgos	Campsa	1951	4,100	Dry.
11. Rojales	Alicante	Ciepsa	1952	4,200	Dry.
12. Villanueva de Rampalay	Burgos	Campsa	1957	7,150	Oil & gas shows.
13. Boltana	Huesca	Ciepsa	1954	7,000	Dry.
14. Baeza 1	Jaen	Adaro	1953	1,340	Gas cut in Miocene
15. Marcilla	Navarra	Valdebro	1953	11,205	Dry.
16. Baeza 2	Jaen	Adaro	1953	2,100	Weak gas shows.
17. Bailen	Jaen	Adaro	1953	2,000	Weak gas shows.
18. Bailen	Jaen	Adaro	1954	2,000	Weak gas shows.
19. Delica	Vizcaya	Campsa	1954	1,640	Dry.
20. Castilfrio	Soria	Valdebro	1954	7,900	Dry.
21. Zuniga 1	Navarra	Ciepsa	1954	6,750	High pressure gas cut.
22. Chiciana 2	Cadiz	Adaro	1956	3,400	Gas & oil shows.
23. Apodaca 1	Alava	Ciepsa	1955	8,350	Dry.
24. San Lorenzo de la Parilla	Cuenca	Valdebro	1955	8,500	Dry.
25. Iglesias	Burgos	Valdebro	1956	6,900	Dry.
26. Puigreig	Burgos	Valdebro	1956	10,200	Dry.
27. Bornos	Cadiz	Valdebro	1956	10,200	Dry.
28. Leva 1	Burgos	Campsa	1956	5,000	Light oils cut.
29. Lano 1	Burgos	Ciepsa	1956	11,600	Gas & oil shows.
30. Matienzo	Santander	Valdebro	1956	6,400	Dry.
31. Orduna 1	—	Iberica	1953	1,767	Methane shows.
32. Almarchal	Cadiz	Valdebro	1957	11,200	Gas shows.
33. Trevino 1	Burgos	Ciepsa	1957	8,500	Dry.
34. Medina Sidonia	Cadiz	Adaro	1957	600	Dry.
35. Leva 2	Burgos	Campsa	1957	6,950	Oil shows.
36. Asperillo	Huelva	Valdebro	1957	10,900	Dry.
37. Isla Mayor	Sevilla	Valdebro	1957	7,800	Dry.
38. Meguer	Huelva	Valdebro	1957	8,100	Dry.
39. Almonte	Huelva	Valdebro	1957	4,250	Dry.
40. Trevino 2	Burgos	Ciepsa	1958	6,562	Some Methane.
41. Ojen	Cadiz	Valdebro	1957	5,745	—
42. Lano 2	Burgos	Ciepsa	1957	7,218	Slight shows methane.
43. Cerro Gordo 1	Cadiz	Valdebro	1959	11,675	Gas & oil shows.
44. Quintana Redonda	Soria	Valdebro	1958	3,782	—
45. Gormaz	Soria	Valdebro	1958	7,218	—
46. Monegrillo	Zaragoza	Valdebro	1958	4,744	—
47. Pamplona 1	Navarra	Valdebro	1959	9,148	Two blowouts of gas & salt water.
48. Pamplona 2	Navarra	Valdebro	1958	5,937	Oil & gas shows.
49. La Zaida	Zaragoza	Valdebro	1958	5,541	Dry.
50. Retuerta 1	Burgos	Valdebro	1958	11,124	Oil & gas shows.
51. Trevino 3	Burgos	Ciepsa	1959	10,282	Slight oil indications.
52. Alloz 1	Navarra	Ciepsa	1959 Drilling	10,598	Dry.
53. Cerro Gordo 2	Cadiz	Valdebro	1959	11,080	Dry.
54. Leva 3	Burgos	Campsa	1958	7,267	—
55. Alda 1	Navarra	Ciepsa	1959	16,503	Shows.
56. Guernica 1	—	Campsa	1959	5,381	—
57. Pamplona 3	Navarra	Valdebro	1960	14,548	Oil & gas shows.
58. La Hoz 1	—	Iberica	1959	2,300	—
59. Aleria 1	Malaga	—	1959	2,759	—
60. Soprenano 1	—	Iberica	1959	1,673	—
61. Soprenano 2	—	Iberica	1959	1,329	—
62. Soprenano 3	—	Iberica	1959	6,276	—
63. Zuñia 1	Navarra	Ciepsa	1960	4,022	—
64. Castillo 1	Alava	Ciepsa	Drilling	12,500	Strong gas shows 99% methane.
65. Pamplona 4	Navarra	Valdebro	Drilling	5,800	—
66. Urbasa 1	Navarra	Ciepsa	1960	12,415	Gas shows.
67. Monesma 1	Huesca	Valdebro	1960	15,584	Gas shows.
68. Urbasa 2	Navarra	Ciepsa	Drilling	—	—
69. Bujaraloz 1	Zaragoza	Valdebro	Drilling	7,500	—
70. Villalda	Burgos	Campsa	Drilling	—	—

MAP 6. PROVINCES OF SPAIN.

Figures under names are approximately number wells completed in each province. In addition many shallow wells were drilled.

wells were omitted, also a number where information was not sufficient.

Ciepsa-Deilmann-Gulf have encountered gas blowouts in their Castillo No. 1 drilling near Vitoria.

Geophysical Operations

Ciepsa has one gravimetric crew in Vitoria and another in Catalonia, 1 seismic crew in Vitoria and one about to start. Also 3 geological crews operating in Vitoria. Ciepsa carried on 10 months of seismic work, 8 months of gravimetric work and 50 party months of geological surface survey in 1959.

Valdebro currently has one gravimetric crew, 2 seismic crews, and 1 geological party operating, all in northern Spain. During 1959 Valdebro undertook 32 crew months of geophysical work.

Campsa has one seismic reflection crew operating in the province of Burgos.

In the Spanish Sahara exploration is being carried out by Union Oil, Richfield and Cities Service.

Manufacturing

The combined capacity of the Spanish refineries is sufficient to satisfy demands in the Spanish peninsula and Spanish territories although some imports are needed to cover specific needs. Present expansion plans already under way for the existing refineries will keep capacity far ahead of consumption.

Total consumption in the Monopoly Area (Spain's mainland and Balearic Islands) has been rising steadily from 11,000,000 bbl for the year 1950 to 35,000,000 bbl for 1959 (See Fig. 1). Present estimates for 1963 are 50,000,000 bbl. Consumption in the Monopoly free territories (Canary Islands, cities of Ceuta and Melilla, Sahara and Guinea provinces) moved from 4,125,446 bbl in 1950 to 5,250,000 bbl in 1959 (See Fig. 2). Estimates for 1963 are 7,000,000 bbl.

Against these consumption figures, delivery of products by the Spanish refineries, which was 4,000,000 bbl in 1950, reached 33,150,000 bbl in 1959. With new expansions under way or projected the total refining capacity will be 70,000,000 bbl/year in 1963.

Oldest refinery in Spain, in the town of Cornella (near Barcelona City) was built for 500 b/d capacity in 1929. It is now shut down and the installation used for storage.

Teneriffe refinery was built by Cepsa in the Canary Islands in 1929-1930. Through subsequent expansions the initial capacity of 5000 b/d has reached its present 70,000 b/d. As normal runs in 1959 averaged 60,000 b/d, some capacity remains unused (Fig. 3).

The installations consist of a Dubbs combination topping and cracking unit with 10,000 b/d crude capacity and 3500 b/d thermal cracking, a two-stage topping and vacuum unit with 7000 b/d crude capacity and 2500 b/d vacuum, a 14,000 b/d one-stage topping unit and another 38,000 b/d one-stage topping unit.

View of Teneriffe refinery in Canary Islands.

Thermal reforming of 3000 b/d naphtha in the cracking section of the Dubbs unit complements the 5000 b/d Platforming to satisfy demands for octane. Several Doctor sweetening plants, Sharpless kerosine acid treatment, leading, dyeing, inhibiting, etc., units provide adequate treating and blending of light distillates.

Specialty products such as aromatics, asphalt, cut-backs and emulsions, lubricants and paraffin waxes come from the refinery. The lubricating oils facilities consist of a 700-900 b/d furfural treating unit of vacuum side cuts and residue obtained in the two-stage plant, a 900 b/d propane deasphalting of vacuum residues to produce bright stocks, a 700 MEK dewaxing and deoiling plant, a percolation unit and the blending and barrelling plant. Total lubricants production capacity is 30,000 tons/year.

A 500 b/d Udex unit for manufacturing benzene, toluene and xylenes has been operating since 1955 with an overall production of about 5000 tons/year.

Steam and power are generated in the refinery to meet all process and utilities requirements.

An expansion program is underway. In 1960 a vacuum section will be added to the 14,000 b/d topping unit, so production of asphalt can be increased to meet growing domestic needs and exportation requirements. Several sweetening units will be converted into Merox, before the end of 1960.

In 1961 a new 50,000 b/d one-stage crude distillation unit and a 15,000 b/d Unifining-Platforming unit are scheduled for operation. Also additional LPG facilities will provide for increased amounts of bottled gas for Cepsa's free markets (outside the Monopoly Area).

Installations such as tank farm, pipelines to the docks, steam and power plant, water treating, etc., are also being expanded.

Cartagena refinery in the SouthMediterranean coast of Spain with a present capacity of 80,000 b/d is the property of Repesa, a joint concern where the

Government enterprise INI holds 52%, Caltex 24% and Cepsa 24%.

Promoted by the Spanish Government, construction of this refinery began in 1942 with the technical assistance of Cepsa personnel and imported materials from Germany. As a consequence of World War II and difficult economical conditions prevailing in Spain for some years after, construction was delayed until April 1949 when a special permission for the formation of Repesa to finish construction and run the Cartagena refinery within the Monopoly Area was given by the Spanish Government.

The first production installations with a 5000 b/d two-stage distillation unit and corresponding auxiliaries were put onstream in late 1949. In 1952 a new 25,000 b/d one-stage distillation unit began operation and the two-stage one was revamped to 9500 b/d. This unit was expanded to a capacity of 40,000 b/d in 1954. A 9000 b/d thermal reforming unit and 1200-bbl polymerization plant went onstream in 1952. In 1954 production of finished lubricants began with furfural treating, propane deasphalting, MEK benzene dewaxing, acid treating, contact filtration, and blending and barrelling. The overall capacity of these plants was 20,000 tons/year of finished lubricants and since then this has been increased to some 40,000 tons/year.

A 1957 expansion incorporated the 80,000 b/d capacity with another 40,000 b/d one-stage distillation unit. Also an 11,000 b/d Platformer was put onstream to satisfy increasing octane demands. New LPG facilities for recovery of butane were installed. This unit is running at full capacity whereas the above mentioned thermal reformer operates at 6000 b/d (below nominal) and the polymerization plant at about 600 b/d.

Finally, a new 35,000 b/d two-stage topping and vacuum distillation unit under construction and scheduled for operation at the end of 1960 will provide an increase of crude capacity to 115,000 b/d and will possibly extend production of lubricants.

The Ohio Oil Company in July filed a proposal to build a refinery in Spain which is aimed at obtaining a market for a portion of its large Libyan crude oil reserves. In association with Compania Iberica de Petroleos of Spain, and some leading Spanish banking interests, Ohio Oil proposes to build a 25,000 b/d refinery on the northern coast of Spain. Through its subsidiary, Ohio Oil International of Libya, Inc., the company holds one-third interest in over 62 million acres of Libyan concessions, with wells testing as high as 11,500 b/d.

If the proposal is approved, the refinery will be scheduled for completion within 24 months from date of approval. Cost is estimated at $18 million with Ohio Oil providing most of the capital. The Spanish government would hold 52% ownership in the refinery while the balance of the ownership would be divided between Ohio Oil and its Spanish associates.

THE AUTHOR

EDUARDO RECASENS, *as assistant head of the technical division, Compania Espanola de Petroleos S.A. (Cepsa), works on process and economical studies, projects for new installations, petrochemical studies, purchasing, etc. His experience in the petroleum industry began in 1937 when he began working in the laboratories and later in processing units of the Teneriffe refinery. In 1947 he graduated as an industrial engineer in the School of Barcelona.*

During 1948 Ing. Recasens spent several months in the USA as a student in Columbia University, New York, and subsequently visited some major refineries and oil fields, finally studying petroleum processing with the UOP staff in Chicago. In 1949 he resumed work with Cepsa at the Teneriffe refinery and later was promoted to headquarters in Madrid.

At present he is also director and one of the technical managers of Cinsa (70% subsidiary of Cepsa) involved in construction of a 110,000 tons/year ammonium sulfate plant in Gran Canaria. He is a member of Spain's National Committee in the World Power Conference.

Shale Oil Distilled

The industrial complex of Puertollano in the province of Ciudad Real is the property of Empresa Nacional Calvo Sotelo of the INI group. Through distillation of shale oil, Puertollano contributes to the Monopoly Area with about 560,000 bbl/year of internal combustion engine fuels and industrial solvents. With imported distillates and bright stock increasing quantity of lubricants, Puertollano can supply the major part of present consumption in the Monopoly Area of about 700,000 bbl/year. Of this, 60% comes from Puertollano. Some 31,500 bbl of paraffin waxes were produced in 1958 and about 35,000 bbl in 1959.

Facilities in Puertollano include a shale oil hydrogenation plant, a distillation unit, an acid treating plant, dewaxing, filtration and blending and barrelling of lubricants.

Petrochemicals Make a Start

Great interest in petrochemicals has developed in Spain during the past years. On one side the Spanish companies Cepsa and Repesa have been studying a variety of processes to be included in their programs based mainly in the production of olefins from light naphthas of which a surplus is being produced and exported.

The Middle East and some Venezuelan crudes run in the Spanish and European refineries do not produce exact consumption requirements. Less gasoline and more middle distillates and residues are in demand so heavier products are emphasized at home and imported.

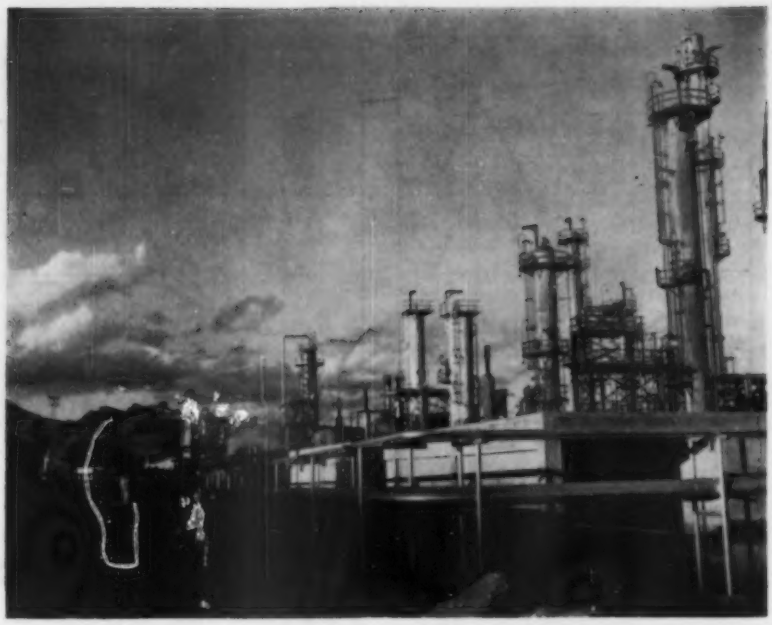
Cepsa as well as Repesa have Platforming units under operation which led to a first consideration of hydrogen and ammonia. Also Cepsa has a Udex plant with a theoretical maximum capacity of 25,000 bbl benzene/year and 40,000 bbl toluene, both nitration grade, apart from a small production of mixed xylenes and ethylbenzene. These brought a proposal for dodecylbenzene manufacture, which has not yet been realized.

With its installations at Puertollano (shale oil and coal distillation) the INI group and Aviles (Iron works) have programs pending a final financial arrangement. This is being negotiated with French and German chemical groups and lately it is said with others.

The Spanish pure chemical companies also have their programs to enter the petrochemical field. The names of several Spanish companies, such as S.A. Cros, Union Espanola de Explosivos, Unquinesa, etc., are frequently mentioned in relation to petrochemicals plans.

In conjunction with Spanish petroleum, chemical and INI groups, some international firms such as Shell, Esso and British Petroleum, as well as chemical companies like Hoestch, Dow Chemical, Imperial Chemicals, and Montecatini have been mentioned as planning ventures in petrochemicals in association with Spanish firms, although no final alignments are clearly established. Monsanto is at present associated with Etino-Quimica.

The first real petrochemical plant is



Towers of Teneriffe refinery.

scheduled to be put in operation in the last quarter of 1960. The plant presently under construction in Las Palmas (Canary Islands) will produce 110,000 tons/year ammonium sulfate from Spanish pyrites and residual fuel oil from the Teneriffe refinery. The plant belongs to a newly-formed company called Compania Insular del Nitrogeno, S.A. It is sponsored by Cepsa (70%) and two chemical companies, Industrias Quimicas Canarias, S.A. and S.A. Cros (15% each).

After elaborate negotiation of a financial arrangement with a credit from the USA Import-Export Bank and some financial aid from France and Germany, Repesa is finally ready to undertake design and construction of a big ammonia fertilizer plant with 90,000 tons/year capacity. The project includes the manufacture of 200,000 tons/year ammonium sulfate, 70,000 tons/year urea and some complex fertilizers. Total cost is estimated at $32,000,000.

There is still another ammonium fertilizer petrochemical project for the production of 200,000 tons/year ammonium sulfate in a plant under construction in Seville. The owner is "Abonos Sevilla, S.A." a joint concern of two chemical companies, Union Espanola de Explosivos, S.A. and Iberica del Nitrogeno. Abonos Sevilla, S.A. was granted a credit last year from the USA Import-Export Bank to help finance the new plant.

As regards other petrochemicals, consideration has been given to ethylene and derivatives such as polyethylene, ethylene oxide, ethylene glycol, propylene, and polypropylene dodecylbenzene, toluene, styrene and polystyrene, polyvinylchloride, synthetic rubber, etc. There are many projects for the construction of plants of various sizes for the production of these petrochemicals but a certain confusion exists as a consequence of the recent changes in the economic development of the country following integration in the OEEC and possible integration in the European Common Market.

At the moment several plants already exist for the manufacture of finished petrochemicals from imported petrochemical base stocks. In 1959 some 5500 lb of dodecylbenzene were imported for the manufacture of detergents. About 11,000 lb of styrene were imported in 1959 for the manufacture of polystyrene. Nylon and perlon are manufactured with imported caprolactam.

Finished petrochemicals are also being imported for moulding, textiles, blending agents, solvents, insecticides, etc. In 1959 some 14,500 lb of carbon black were imported along with about 8500 lb of polyethylene, Dacron, etc.

Present and Future Prospects

The swift turn from controlled economy to a progressively freer one has imposed a revision on all plans and programs. Restriction in domestic credits and measures undertaken to stabilize the peseta has brought about a restrained attitude with keen consideration of marginal production. There is more study of each project in the light of economic efficiency. Such items as size of units and their adequate organization, market prospects, sales promotion, etc., are being determined more closely.

For existing chemical companies future protection through import duty is the source of some worry. They are concerned with immediate or future modernization of their plants and about expansion of their activities.

To carry through the complete programs without foreign aid at the moment seems to be out of the question because the Spanish economy is not yet capable of supplying the huge sums required for the purpose.

We can finally say that present development of petrochemistry in Spain is at an early stage and because of the recent trend toward a free economy its future is somewhat unpredictable at this moment.

Distribution Facilities

Importation, refining and handling, storing, distribution and marketing of mineral oils and derivatives have been a monopoly of the State since 1927. Campsa is the administrator and lessee of the State Monopoly. The trend toward free economy encourages some to believe this monopoly will be abolished by the Government. Part of Campsa, it should be noted, is private property.

Spain is, so far, well supplied with ports, pipelines, tank cars, and tank trucks for distribution of oil products. Storage capacity, however, totals only 7,500,000 bbl. Plans are underway to increase this volume. Many service stations are property of Campsa but are leased out to individuals.

Campsa does not have the monopoly on marketing in Spanish territories. Distribution in these is shared by Mobil Overseas, British Petroleum, Shell, and Atlas (subsidiary of Cepsa). Ifni and Spanish Sahara are served only by Atlas. Further south at the port of Villa Cisneros, Cepsa owns a storage installation used mainly for aviation fuels. In the Canary Islands distribution is made by Mobil Overseas, Texaco, Shell, and DISA (subsidiary of Cepsa), all of them selling products from the Teneriffe refinery.

The Canary Islands are strategically located 60 miles off the African coast in the crossroads of many sea lanes from Mediterranean ports to the Western Hemisphere in South Africa. They are an ideal center for refueling which explains the presence of Esso, Shell, Mobil, Texaco, BP and Cespa. Bunker services in the Canary Islands exceed 2,000,000 tons/year, about 40,000 b/d. In Spanish Guinea, Mobil and Alada (Cepsa) distribute supplies coming from the Teneriffe refinery.

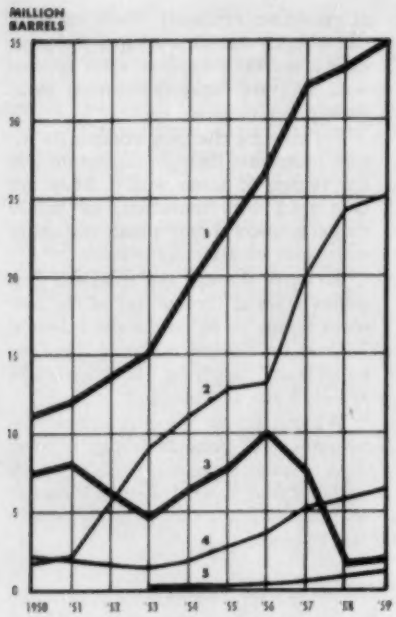


FIG. 1. Consumption in the Monopoly Area

1. Total consumption.
2. Supplies from Cartagena Refinery.
3. Direct imports by Campsa.
4. Supplies from Teneriffe Refinery.
5. Supplies from Puertollano installations.

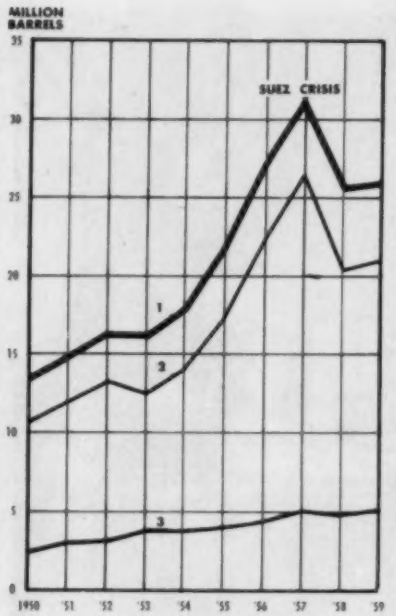


FIG. 2. Consumption in the Monopoly Free Territories

1. Total consumption inland and through ship bunkering.
2. Bunkering to Spanish and foreign ships by Spanish and foreign companies.
3. Inland consumption.

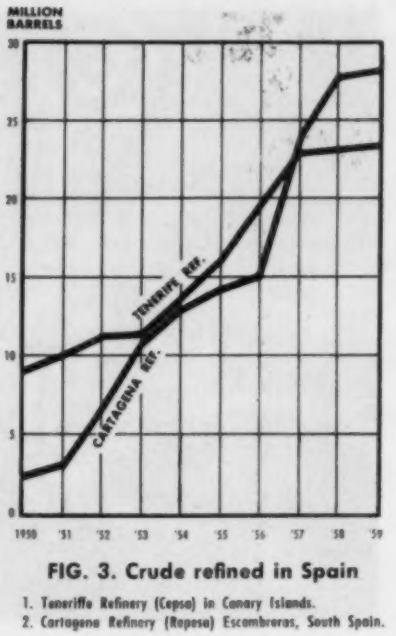


FIG. 3. Crude refined in Spain

1. Teneriffe Refinery (Cepsa) in Canary Islands.
2. Cartagena Refinery (Repesa) Escombreras, South Spain.

From this refinery a wide variety of products are exported to African countries. Aromatics go to Northern Europe and Australia and asphalt to Asia and South America.

From the Cartagena refinery Repesa exports naphtha, gas oil, and butane to several Mediterranean countries.

Market Facts and Figures

Fig. 1 shows consumption curves in the Monopoly Area with integrating supplies from the Teneriffe and Cartagena refineries and import curves during the last decade.

Imports of finished products in the last decade have decreased from roughly 7,000,000 bbl in 1950 to about 1,850,000 bbl in 1959. This last being mainly fuel oil (part lubricating oils).

Aviation gasolines and lubricants are being imported as no alkylation plants exist in Spain and so far no expansion plans include those units. The present capacity for lubricants will be sufficient when expansion of the Cartagena refinery is completed.

The Cartagena refinery receives crude supplies from the Middle East under contracts with Caltex and Shell. Transportation is about 60% in tankers under the Spanish Flag which in part are the property of Repesa. Products from the refinery are loaded on Campsa tankers and transported to coastal terminals.

TABLE 4. Consumption in the Monopoly Free Spanish Territories in 1959.

	bbl/yr
Canary Islands and Ceuta and Melilla, North Africa	2,400,000
Spanish Sahara	29,500
Spanish Guinea	112,000
Bunkering in Ceuta	4,100,000
Bunkering in Canary Islands	17,100,000
Total outside Monopoly area	23,741,500

TABLE 5. The Tanker Fleet.

Year	Deadweight tonnage
1955	210,815
1956	252,867
1957	268,387
1958	305,838
1959	521,601
Under construction	567,300

The Teneriffe refinery receives crude both from the Middle East and the Caribbean area (Venezuela) through contracts with British Petroleum, Gulf, Shell, Esso, and Mobil, and also from royalty production in Venezuela. Cepsa transports 50% of these crude supplies in Spanish tankers.

Products transportation from the Teneriffe refinery to the Monopoly Area is made by Campsa tankers, whereas transportation to African markets is made directly by Cepsa's own fleet. Products are refined under a processing agreement with British Petroleum and Mobil Overseas.

Tanker construction in Spain proceeds at full capacity because of efforts to nationalize petroleum transportation, with promotion by the Government awarding long-term loans. Controlled freight with prices above the international average tends to increase tanker construction.

As a result not only the petroleum companies in Spain—Campsa, Cepsa, Repesa and Calvo Sotelo—are increas-

TABLE 6. Value of Imports and Exports.

	CURRENCY EXPENDITURES in $ USA					
	Imports			Exports		
Year	Cost of products	Freight	Total imports value	Value of exports by CEPSA	Value of exports by REPESA	Total exports value
1956	$ 90,608,012	$10,657,507	$101,265,519	$ 8,148,756	—	$ 8,148,754
1957	111,496,495	17,639,231	129,135,716	10,394,724	1,046,599	11,441,323
1958	112,947,780	7,877,995	120,825,775	8,378,178	3,398,853	11,777,031
1959*	125,337,958	8,658,449	133,996,406	11,408,301	2,294,500	13,702,801

*Estimated.

ing their fleets with new units but also private companies and individuals have programs under way. And all this at a time when many tankers are idle (Table 5).

Economics Today

To control currency expenditures for petroleum crude and products a national committee (Comision Nacional de Combustibles) was created by the Government in January 1957. Since then closer control of refining and consumption has been enforced through yearly plans for imports to meet domestic and export market demands. These plans are prepared in advance with Campsa, as distributors, and Cepsa and Repesa, as refiners.

Total currency expenditures for importation of crude oil, distillates, finished products and corresponding freights in the last four years are shown in Table 6.

Exports offset some of this. Largest amount is made from the Canary Islands refinery because of its location in the Atlantic crossroads.

National refinery prices for petroleum products delivered to Campsa have always been maintained at international levels with a discount of about 10% in comparison with direct import cargoes.

After devaluation of the peseta from 42/$1 to 60/$1 in June 1959, a complete revision of refinery prices, taxation and retail prices was enacted.

In the Canary Islands, the North African cities of Ceuta and Melilla, the Spanish Sahara and Spanish Guinea, the prices to consumers are lower because of lower taxation. The Canary Islands have become a sort of open market with substantial imports of lubricants.

In the Future

Spain has gone through a struggling period since the 1936-39 Civil War, aggravated by political and economic isolation which lasted well after World War II. General Franco, leader of the conservative forces, was victor against the Communists in 1939 but with World War II the Allies were teamed with Russia.

In recent years the Spanish Government has turned to fewer economic controls and better political relationships with the Western World.

Few events could affect its economic well being more than the Government's decision to invite, with equitable laws, outside capital and effort in developing petroleum resources.

The future looks brighter. Spain is moving up to join other Western Europe countries in a wide and spreading progress. ★ ★ ★

Directory of Supply and Service Companies in Spain

AEROQUIP CORP. (hose lines, fittings, self-sealing couplings).
Distributor: Industrias Subsidiarias de Aviacion, S.A.
Seville: Apartado 250, San Jeronimo. Tel: 24894, 3, 2, 1.
Cable: ISA Clave.

BUCYRUS-ERIE CO. (power excavators, and cranes; percussion and rotary drills).
Distributor: Gumersindo Garcia S.A.
Madrid: Gral. Martinez Campos 3.
Tel: 577000. Cable: INGE. Mng. Dir.: Sr. Gumersindo Garcia.

CARRIER INTERNATIONAL LTD. (air conditioning, heating, refrigeration).
Distributor: Auto-Electricidad, S.A.
Madrid: C. Coello 85. Tel: 36 33 10. Cable: AUTOBAT.
Barcelona: Diputacion 234. Tel: 22 65 50. Cable: AUTOBAT. Mgr.: R. Bufill C.

CLARK BROS. CO. (gas turbines, engines, motor-driven compressors, centrifugal compressors).
Distributor: L. E. Jackson.
Madrid: Calle Mayor 4-5°, Despacho #2.
Barcelona: Plaza Cataluna 21, 3°. Cable: LOTEX.

Du PONT de NEMOURS & CO., E. I. (tetraethyl lead and other petroleum additives)
Distributor: Commercial Quimicas Masso S. A.
Barcelona: Valencia 320, 2°, 2°. Tel: 55 15 06. Cable: QUIMCASSO. Pres.: Juan Masso.

CONTINENTAL-EMSCO. (drilling and producing equipment).
Distributor: Suministros Continental.
Madrid: Castellano Hilton Hotel. Tel.: 57-22-00. Cable: PARACLOSE. Sales Repr.: Capt. Forrest Close, USNR.

CURTIN & CO., W. H. (laboratory apparatus, petroleum testing equipment, reagent chemicals).
Distributor: Anglo Espanola de Electricidad, S. A.
Madrid: Magallanes 80.
Barcelona: 11 Ave. Jose Antonio 525. Tel.: 24-38-00. Mgr.: Royston Noble.

ENGELHARD INDUSTRIES (petroleum catalysts).
Distributor: H. DeTrauttenberg.
Madrid: Avenida Calvo Sotelo, 18.
Mgr.: H. Detrauttenberg.

FAILING CO., GEO. E. (rotary drilling rigs, drill pipe, bits, etc.).
Distributor: Maquinaria, S. A.
Madrid: Apartado 45. Marques del Riscal, 2. Tel: 23 95 02. Cable: ROWAID. Mgr.: Robert Waid.

FALCON SEABOARD DRILLING CO. (drilling contractor).
Distributor: Falcon Seaboard of Panama, S. A.
Las Palmas de Gran Canaria: Menendez y Pelayo No. 25, 1°Derecha, (Entrada por N. de la Torre) Suite No. 5. Cable: FALCONSA. Mgr.: Fred E. Fisher.

HERCULES MOTORS CORP. (gasoline and diesel engines, power units, parts).
Distributor: Hercules Motors Iberica.
Madrid: Toledo 94. Tel.: 27199. Mgr.: A. Conde Medin.

HUNTING SURVEYS (air survey and natural resources)
Distributor: Sr. Adrian Gallegos.
Madrid: Nunez de Balboa 100.

IDECO-DRESSER INDUSTRIES (drilling rigs, drilling and producing equipment).
Distributor: Suministros "Shag" S. A.
Madrid: Av. Menendez Pelayo 2. Tel.: 35-08-00. Cable: SUSAG.

INGERSOLL-RAND CO. (compressors, pumps, vacuum equipment, condensers, ejectors, air and electric tools, hoists and rock drills).
Madrid: Apartado 518. Calle Montalban 5. Tel.: 214710. Cable: INGERSOLL. Mgr.: M. Olea.

INSLEY MFG. CORP. (parts for excavators, cranes and concrete equipment).
Distributor: Impex, S. A.
Madrid: Alcala 63.

LeTOURNEAU-WESTINGHOUSE (construction equipment).
Distributor: Gumersindo Garcia, S. A.
Madrid: Apartado 731, 3 Martinez Campos St. Tel.: 57 70 00. Cable: INGE. Mgr.: Gumersindo Garcia.

MARTIN-DECKER CORP. (indicating and recording drilling control instruments).
Distributor: Robert T. Waid, Jr.
Madrid: Apartado 45, Marques Del Riscal 2. Tel.: 23-95-02. Cable: ROWAID. Mgr.: Robert T. Waid, Jr.

NATIONAL SUPPLY CO. (oilfield supplies).
Distributor: Maquinaria, Sociedad Anonima.
Madrid: Apartado 45, Marques Del Riscal, 2. Cable: ROWAID. Mgr.: Robert T. Waid, Jr.

SHELL CHEMICAL CORP. (industrial and agricultural chemicals, plastics, resins, rubber).
Distributor: Sociedad Petrolifera Espanola Shell.
Madrid: Apartado 652, Alcala 45. Cable: SHELL.

UNION CARBIDE INTERNATIONAL CO. (synthetic organic chemicals).
Distributor: Quimidroga, S. A.
Barcelona: Via Layetana 33, 5th Floor. Tel.: 22-07-54. Cable: QUIMIDROGA. Mgr.: Sr. Emilio Farran.

UNITED GEOPHYSICAL CORP. (geophysical surveys).
Las Palmas: Calle Triana No. 140, Las Palmas, Gran Canaria Isles Canarias. Tel.: 2-1149. Cable: UNITEDGEO. Mgr. Thomas G. Mills.

WILLIAMSON, INC., T. D. (tapping machines, stopples, pigs, casing seals, insulators).
Madrid: Paseo de la Castellana 1. Tel.: 230358 and 230525. Mgr.: Mr. Acquani.

WORTHINGTON, S. A. (pumps and compressors).
Madrid: 173 Embajadores. P. O. Box 372. Mgr.: J. Maldonado.

YOUNG RADIATOR CO. (heat transfer products).
Distributor: Anglo-Espanola de Electricidad, S. A.
Barcelona: 11, Av. Jose Antonio 525. Tel.: 23-85-21. Mgr.: Royston St. Noble.

HOW TO BE A MANAGER

Evaluate Your Political Views

Joseph J. Eley

"We have given you a free republic — if you can keep it." — Benjamin Franklin

AFTER FIVE YEARS of working with managerial personnel in seminars on politics, we have the firm conviction that knowledge of politics and public affairs among managers is woefully lacking. This excludes, of course, legislative matters that directly and intimately affect the specific company and industry but the generalization stands up well in regard to the broad spectrum of issues, affairs and matters political. No matter what the excuse, this lack of political sophistication among managers bodes ill for a society in which management personnel should constitute an important part of the backbone of national strength.

In a series of questionnaires as part of a teaching course, we noted that over 9 out of 10 managerial personnel cannot name the leadership of their political party in their communities; the same 9 out of 10 cannot identify their delegates to state or national nominating conventions; 7 out of 10 cannot identify their state legislators, over half cannot name their representatives in Congress.

What you don't know hurts!

In the area of issues, mention of the Forand bill evokes puzzled expressions. The ramifications of the Landrum-Griffin bill escape most, the soil-bank program and agricultural legislation is outside the comprehension of the overwhelming majority. There is even less understanding of state affairs. Yet out of the management force comes the succession of policy makers of our business enterprises, and policy in the corporate body cannot be made without an eye on the political barometer. In essence, it becomes clearer and clearer that the business enterprise needs politically-sophisticated men at the helm.

POLITICAL SKILL ESSENTIAL

A grasp of market conditions and directions, knowledge of factors of competition, of the secrets of finance, of production, administration and organization; all the components of managerial skill are not enough, there needs also to be depth knowledge of the political facts of life. Out of these comes the climate in which the business enterprise must be operated. Only if there is this understanding of the currents and crosscurrents of politics can the manager determine why and how the political climate effects his business and what to do about it.

In order to "evaluate your political views" the individual ought to start with an understanding of our political system and how it works. Specifically, he ought to understand the party system; how the political party is constituted and how it selects its leaders. These are matters which differ somewhat from state to state. They are usually determined by the state laws which govern elections and by the rules or by-laws of the party committees at county and state level.

He ought to reject the common fallacies applied to politics. The wicked old saw, "politics is a dirty business," won't stand up under even minimal logical examination. He ought to note that compromise and expediency are words of reasonable connotation except when applied to politics. The too-frequent conclusion is that political compromise and political expediency are extra-evil. A very practical politician, Lyndon Johnson, summed up this point recently saying, "I always seek the best and do the possible." Those words are the hallmark of most practical politicians.

Among the questions most frequently posed by managers in political seminars is "what is the difference between the political parties?" The implication is that the parties ought to provide clear-cut and rigid political philosophies. The response to the question is best given in the form of a question "Whose Democratic Party do you mean? That of Sen-

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Joseph J. Eley, *is president of Public Affairs Counsellors, Inc., New York. Former newsman, editor, and public relations executive, he is an alumnus of Morris Harvey College where he majored in political science. After World War II service in the Philippines and Japan, he edited the West Virginia Review. Later he was a radio news commentator and manager of the Weirton, West Virginia Chamber of Commerce. He served as Director of Publicity and Publications for Freedom Foundation before he became associated with the public relations firm of Bozell and Jacobs, Inc. As executive vice president of Effective Citizens Organization, he directed practical politics seminars on university campuses, including Princeton, Stanford, Michigan State, Southern Methodist and Southern California.*

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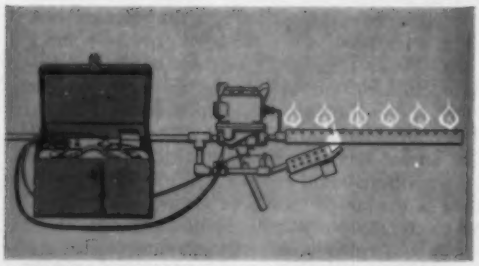

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ator Byrd of Virginia or that of Senator Humphrey of Minnesota? Whose Republican Party? Senator Goldwater's or Senator Case's?"

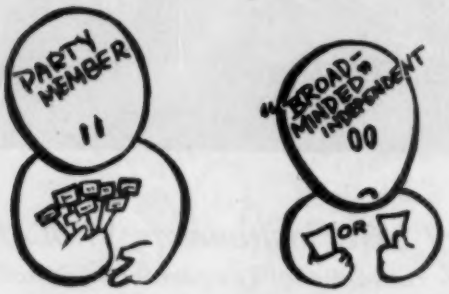
POLITICAL PARTIES ARE DEVICES

The answer is, of course, that political parties are not philosophic bodies. Both major parties range far and wide in ideas and philosophies. Both major parties seek less an ideological unity than a working consensus through which to get a job done.

This is not meant to suggest that the individual should surrender his own ideas and ideals; it means only that he should not expect the political party to offer him a neatly-packaged, be-ribboned philosophy. Rather, he might consider the parties as devices of convenience through which he may express his philosophy in the nominating and election process.

Which party he chooses to associate himself with should depend on a variety of circumstances summed by the word "comfort." The party in which he feels more comfortable is the party for him.

The foregoing references ignore the status of the so-called "independent" voter. By way of definition, this is the Walter Mitty of politics whose delusions are expanded by some journals of opinion which tell him he is the balance of power politically. Because he affiliates with neither party, he is regarded as unprejudiced, objective and "clean." Sterile is a better reference for this poor soul. Through his lack of participation as an enrolled party member he surrenders



The independent surrenders some rights and limits his choice.

in the majority of states his right to participate in the nominating process. He misses his opportunity to participate in primary elections or in party caucuses; his choices are limited in the general election to candidates selected by the members of the parties; usually he can pick one of two. The party member may have scores from which to select.

Strangely, many people apparently believe that affiliating with a political party carries with it the moral obligation that one must support every candidate his party offers in general elections. This is, of course, a fiction. There is no such "moral" obligation even for a party officer. The sanctity of the voting booth is extended to all.

PARTY REGULARITY WORTH EFFORT

There is much to be said, however, for party regularity. The strongest props under our representative democracy are two strong political parties. Strong parties are built on party regularity. A successful party is more likely to attract good candidates.

In sum, we believe strongly in party regularity, so that the party may achieve the aforementioned working consensus, but we retain for others and for ourselves the right to "cross over" when conscience suggests this action.

One major deterrent to political activity on the part of managerial personnel seems to be the matter of involvement in "controversial" matters. The political parties and, therefore government, undoubtedly have been robbed of a range of capabilities because of fear of controversy.

Allen Drury in his excellent book, *Advise and Consent*, speaks at one point of the "equivocating man." One man's interpretation of the "equivocating man" is found in so many circles; the man who refuses to take sides; who will neither be for nor against anything if he can avoid it. The "smart" way, says the equivocator, is to be neutral.

Yet the equivocating man does not defeat communism or socialism in its efforts to undermine his precious heritage. The equivocating man—or society—achieves no lofty ideal. An equivocating society will produce an equivocating government, just before it produces an authoritarian form or crumbles under its own bumbling.

CONTROVERSY SPURS PROGRESS

Controversy within proper limits is good for the man and good for the society. It challenges imagination, spurs ideas, nurtures alternatives. Tempered with the proper degree of moderation, it spurs progress.

The equivocating company is as bad, or worse, than the equivocating man. Certainly, no one can argue the practicality and propriety of a company refraining from becoming involved in public affairs that are clearly and purely none of its business.

But the policies of many companies of several decades duration precluded managerial personnel from political activities and limited the voices of the business system to only the narrowest of issues. This was a disservice to the entire population of our country.

The voters cannot choose alternatives unless alternatives are clearly and concisely offered! If those who symbolize responsible private enterprise provide no debate, no ideas, no solutions to problems, who will defend the ramparts of the business system? There is much to provoke thought in the expression "an attack on any part of the free enterprise system is an attack on the whole." The minimum that can be said is that equivocation will breed the destruction of free enterprise and even freedom itself.

If there is one constant and general excuse among managers to avoid political participation, it is the refrain, "but, I don't have time for politics. I work ten to twelve hours a day at my job." Aside from the fact that the man is frequently kidding himself (though not often his boss) the obvious answer is that the citizen has no alternative but to find time. The suggestion is often made that the "have-no-timers" ought to set their priorities in order. We submit that religious activities should receive top priority, the economic interests of the family should be second, and political participation next. Hobbies, recreational activities, civic contributions should come after the individual wields the maximum political influence that can be achieved to protect his destiny and his family's destiny, which includes job security.

DON'T BEGIN AS A BOSS

The manager approaching politics should be realistic enough to know that he cannot necessarily transfer his prestige and standing in his company to the political party. Too many men, having arrived at a position of eminence in business, expect automatically to be state chairman or at least county chairman of the political party. Their attitude is that they render a favor to the political organization by participation. Politics has its peculiar skills, and an executive may

lack the experience and grasp to provide political leadership at these levels.

His better course, and the one which will help him achieve political influence more rapidly, is to volunteer his efforts to the party leadership, to accept the assignments given him and to build soundly even though slowly to a position of influence.

DON'T FIGHT CITY HALL

Pertinent here also is the observation that the newcomer should resist running against the "organization," unless or until he has the votes to beat the organization. The latter reference is valid only if the necessary nose-counting is done on the most realistic of bases. Even the politician whose formal education was most neglected is usually highly competent in mathematics, at least, in counting the voters on whom he can depend. The ability to count accurately has often been the difference between the organization and the best-intentioned but politically unsophisticated idealist.

HOW TO STUDY CANDIDATES

To this point, there has been no discussion of candidates and issues as part of the political mural. In regard to candidates, the most pressing question the writer has encountered is, "How do I get to know about candidates?" Implicit in this is the suggestion that reading the newspapers and watching television performances is not enough.

The press, meaning the broad spectrum of news dispensing media, seeks to do the best job possible of informing the voter. The best informed individual politically, however, is the intelligent party worker. He gets more exposure to candidates under diverse circumstances than the non-participant by far. He learns also that the better approach is to find and support men of integrity. He can depend on that integrity, with his continuing support, to produce better government. He learns not to generalize, that men are not rigid creatures and that they are usually products of their environment.

HOW TO STUDY THE ISSUES

Issues are even more intricate. Here, so much depends on the integrity of the candidates.

It has become, it appears, part of the political mores of our country to expect the candidates for every office to be experts on the wide range of public issues. The result is that we are often offered fast and easy solutions to problems which require much more complex responses.

In addition, the solutions offered by candidates in a campaign situation are usually based on circumstances present at the time of the speech or presentation. Those circumstances may be altered considerably by the time the candidate has been elected and is in a position to vote as a legislator or administer as an executive.

The answer again lies largely with good, vigilant political organizations producing candidates with integrity. If this appears to be an overly simplified answer, it is at least much more sensible than our present smug feeling that our electoral decisions are being made by an informed citizenry.

CHOOSE OR SOMEONE CHOOSES FOR YOU

The path, then, to "evaluating your political views" lies in being a part of the process that produces government, that is, the political party process. Carry your ideas and ideals into a party and fight for them and candidates and issues will be within range of your guns.

Remember, if you are not helping to select candidates, someone else is. If you choose to invest your destinies in others, if you prefer to take the kind of government others

mold for you, that's your affair. History is replete with tales of civilizations which fell when its people bowed to apathy.

From somewhere in the recesses of memory, a statement comes into focus: "When little men begin casting long shadows, the sun is setting on a nation."

Try to Complete This . . .

WHERE YOU LIVE . . .

Name:_____

Address:_____

_____

YOU LIVE IN . . .

Precinct_____

County (Parish) District_____

Legislative District_____

Congressional District_____

YOUR POLLING PLACE . . .

_____

_____

COMMITTEEMEN IN YOUR PRECINCT

Republican_____

_____

Democratic_____

_____

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EARNINGS EDGE UP FOR HALF YEAR

Second quarter shows encouraging turn after slow 1960 start

ERNESTINE ADAMS

THE U. S. PETROLEUM industry battled to keep up with revenues and earnings for 1959 in the first half of 1960. There were two bright spots in the very mixed-up picture of financial returns. One was the fact that the first half of 1959 had a 26% increase over 1958 and was a record hard to improve upon.

The second encouraging aspect was that the second quarter for some strange reason was higher than the first quarter, when usually it's the other way around. This year's first quarter reports showed earnings off 1% while the first half reports show earnings up 1.3%.

Second Quarter Better

Several companies mentioned this peculiarity. Says Standard Oil (Indiana), "Contrary to the normal seasonal pattern, earnings for the second quarter of 1960 increased over the first-quarter earnings."

Atlantic reported a 63% improvement in profits for the second quarter over the same period last year, enabling the company to complete the first half with earnings nearly equal to the 1959. "Favorable performance," said the report, "is an early reflection of our intensive efforts to counter this profit squeeze which the oil industry is experiencing."

Signal Oil and Gas Company's report showed a 26% increase in the second quarter earnings over those in the first quarter. American Petrofina reported that toward the end of the second quarter, an increase in demand of refined products and some improvement in prices provided a substantial recovery in earnings for May and June.

In June some correction of depressed product prices were corrected, Clark Oil and Refining explained, and the company was able to show a slight improvement in earnings during the second quarter.

First Half Problems

About half the companies showed less earnings than in 1959. There were a variety of reasons for this. TXL explained that two principal factors account for the decline in its earnings. One, heavier dry hole and geophysical costs, and two, fewer producing days.

As General Crude Oil Company pointed out, production in Texas was restricted to 55 days, when in a comparable period last year there were 68 producing days. Skelly Oil Company reported the severe state proration combined with lower crude oil prices caused its lower income.

"The principal factors contributing to the decrease in earnings were lower average prices for refined products, higher costs of our accelerated foreign exploratory operations, particularly in Libya, and a reduction of 2.8% in net production of liquid hydrocarbons," Ohio Oil Company explained.

Sunray's net income was said to be adversely affected by lower gasoline and fuel oil prices. Universal Consolidated stated that compared to 1959 average crude oil price was 18¢ per barrel less.

In addition to "severe softening of price structure for gasoline," Anderson-Prichard named uncalled-for local price wars as a factor in reduced earnings.

Drilling

Although drilling activities were down, there are prospects that the last half will be better. Continental showed a decrease of $3.5 million in intangible drilling costs, which resulted from a combination of fewer well completions, more shallow wells and increased efficiency in drilling operations. Crescent Petroleum foresaw considerable development drilling on its holdings in Kansas and Texas. Olin Oil and Gas said that unseasonal weather had resulted in a slower rate of well drilling, but it planned an accelerated program of both wildcat and development drilling for the remainder of the year.

Contractors had something to say about this, too. Drilling and Exploration reported that contract drilling realization was based on emphasized foreign operations as domestic contract drilling showed an operating loss. "During the first half of 1960, 21,356 wells were drilled in the United States, 12% fewer than the 24,367 wells drilled in the first half of 1959."

Ocean Drilling and Exploration said that its higher earnings were due in part to near capacity employment of contract drilling equipment at improved rates.

Refining

There was awareness of the oversupply in refined products. In its report, Cities Service said it "carried forward its policy of self-restraint in refinery runs and strict inventory controls during the first half." Crude runs to its domestic refineries averaged 6% below the same period in 1959.

Ashland Oil and Refining said "As a contribution toward the reduction of inventories of refined products, we have operated our refineries at less than their most efficient capacities." Reported Colorado Oil and Gas, "It is essential for the industry to maintain refinery runs in proper balance with market demand. Our company accordingly is processing through its refinery only volumes which it can reasonably expect to sell through normal marketing channels."

Standard (Indiana) said "The industry must exercise more restraint in re-

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finery runs if excessive inventories are to be avoided in the late summer and in the fall."

According to Pure Oil Company: "While conditions underlying the recent improvement appear to be sound, price stability in the industry for the remainder of the year depends to a major degree on whether refinery runs are held to a reasonable level."

Improvements Made

Several mentioned increase in natural gas and petrochemical sales as reason for better earnings. Gulf pointed to increased production of crude oil and natural gas and higher levels of petrochemical sales in the United States. Phillips mentioned that crude oil production in Venezuela increased and sales value of petroleum chemicals was higher.

Improvement reflected increased volume of crude oil production and growth in sales of oil, gas and chemicals, stated Standard of California. With operations at record levels Texaco reported that properties taken over by the Cuban government would not be material in relation to the company's consolidated earnings for the year.

Union Oil of California credited improved natural gas sales for earnings increases. Ambassador Oil Corporation said its sharp increases resulted from waterflood oil production and natural gas output.

Operational improvements were mentioned as another cause for increased earnings. Texas Pacific Coal and Oil Company emphasized "operating economies at every level." Tidewater said "Gain is primarily due to more favorable marketing conditions and successful effort to improve profitability and reduce costs."

Future Looks Up

Despite the seesaw economy there was considerable optimism for the future. Signal had the first independent survey of its properties which showed recoverable reserves of 590 million barrels of proved and 379 million barrels of potential oil. Natural gas reserves amounted to one trillion cubic feet and 72 million barrels of liquid products. Douglas Oil in its fiscal year beginning March 31 plans to erect 60 new stations in the West. Delhi Taylor had the happy experience of underestimating its earnings for 1960. It showed a 48% increase in the first half of 1960.

Cosden Petroleum reduced the problems of the industry to one sentence, "From time to time we have problems that are difficult to resolve, but it seems our greatest difficulty is in slowing down our operations to let other basic industries catch up." ★ ★ ★

FIRST HALF REPORTS OF PETROLEUM COMPANIES

Company	Gross income ($1000) 1959	1960	% change	Net income ($1000) 1959	1960	% change
Ambassador	$ 2,588	$ 3,278	+27	180	694	+286
Amerada Petroleum	52,526	51,829	— 1	11,662	12,059	+ 3
American Petrofina	38,428	35,530	— 7	355	(385)	—208
Anderson-Prichard	35,787	36,618	+ 2	3,044	2,167	— 29
Argo Oil Corp.	6,806	7,057	+ 3	1,976	2,080	+ 5
Ashland Oil & Ref.[2]	228,567	229,955	+ 1	10,532	9,929	— 6
Atlantic Refining	279,967	280,578	+ 1	17,356	16,917	— 3
Aztec Oil & Gas	3,942	4,167	+ 6	2,551	2,444	— 4
Bishop Oil	961	994	+ 3	(19)	53	+379
British American	156,658	158,019	+ 1	9,591	14,800	+ 54
Champlin Oil & Ref.	42,778	41,090	— 4	4,287	3,362	— 22
Cities Service	513,576	493,729	— 4	18,904	18,672	— 1
Clark Oil & Ref.	41,184	42,094	+ 2	1,006	208	— 80
Coastal States	1,846	—	—	634	—	—
Colorado Oil & Gas	21,914	22,587	+ 3	1,034	(313)	—130
Commonwealth Oil Ref.	30,701	33,920	+10	(127)	1,048	+925
Continental Oil	383,793	395,400	+ 3	29,200	28,500	— 2
Cosden Pet.[1]	83,077	83,293	0	4,517	4,763	+ 5
Crescent Corp.	11,170	11,021	+ 1	1,382	1,416	+ 2
Delhi-Taylor	42,950	47,300	+10	1,450	2,150	+ 48
Douglas of Calif.[5]	30,844	31,412	+ 2	(415)	1,009	+343
Drilling & Exploration	5,115	4,813	— 6	359	282	— 21
Eason Oil	1,941	—	—	278	—	—
Felmont	4,505	4,878	+ 8	1,315	1,508	+ 15
Frontier Ref.	15,289	—	—	241	—	—
General American	13,310	—	—	2,732	—	—
General Crude Oil	6,891	6,189	—10	1,952	1,016	— 48
Getty Oil	21,127	21,242	0	4,295	4,491	+ 5
Gulf Oil Corp.	1,572,320	1,604,333	+ 2	141,814	156,096	+ 10
Helmerich & Payne	6,825	7,490	+10	244	359	+ 47
Honolulu Oil	22,288	23,568	+ 6	6,444	5,615	— 13
Hugoton Prod.	4,093	3,714	— 9	1,978	1,776	— 10
Leonard Refineries	27,887	26,783	— 3	617	768	+ 24
Louisiana Land & Exp.	18,255	22,150	+21	9,169	11,062	+ 21
Macmillan Pet.	6,952	7,005	+ 1	279	348	+ 25
Maracaibo	890	842	— 5	139	118	— 15
Midwest Oil	10,544	10,068	— 5	3,471	3,399	— 2
Monterey Oil[2]	17,591	16,802	— 4	1,887	1,445	— 23
Murphy Corp.[1]	45,494	57,314	+26	3,500	2,919	— 17
Ocean Drlg. & Exp.[1]	6,430	7,700	+20	(431)	520	+221
Ohio Oil	143,990	175,973	+22	18,556	17,733	— 4
Olin Oil & Gas	20,698	23,551	+14	2,074	1,575	— 24
Phillips Petroleum	597,579	603,099	+ 1	53,209	51,748	— 3
Plymouth Oil	48,556	41,112	—15	2,184	43	— 98
Producing Properties	3,840	4,521	+18	162	825	+409
Pure Oil	308,130	328,452	+ 7	13,148	13,756	+ 5
Quaker State	27,869	26,386	— 5	1,004	785	— 23
Richfield Oil Corp.	166,050	174,672	+ 5	10,696	13,988	+ 31
Shamrock Oil & Gas	28,271	32,014	+13	4,786	4,460	— 7
Shell Oil	894,247	898,199	— 0	69,187	69,312	0
Signal Oil & Gas	80,131	151,880	+90	8,659	7,604	— 12
Sinclair Oil	627,617	622,960	— 1	26,600	21,662	— 19
Skelly Oil	132,019	125,236	— 5	13,967	11,090	— 21
Socony Mobil Oil	—	—	—	77,144	83,400	+ 8
South Penn	28,459	29,818	+ 5	1,796	1,898	+ 6
Standard (Calif.)	919,132	980,710	+ 7	118,153	128,589	+ 9
Standard (Ind.)	997,037	1,000,316	0	78,851	64,887	— 18
Standard (N. J.)	4,255,000	4,317,000	+ 1	315,000	315,000	0
Standard (Ohio)	183,643	182,012	— 1	9,881[4]	10,956	+ 11
Sun Oil	385,315	366,800	— 5	21,974	20,032	— 9
Sunray Mid-Cont.	228,424	229,103	0	20,948	18,743	— 12
Superior Oil[3]	101,218	95,146	— 6	22,972	18,550	— 19
Texaco, Inc.	1,386,845	1,529,591	+10	164,961	177,342	+ 8
Texas Gulf Prod.	8,774	8,174	— 7	2,092	2,414	+ 15
Texas Pacific	13,215	13,247	0	3,642	3,968	+ 9
Tidewater Oil	278,416	287,729	+ 3	18,633	18,277	— 2
TXL Corp.	6,910	6,510	— 6	2,243	1,290	— 38
Union Oil Calif.	247,893	258,944	+ 4	10,772	13,370	+ 24
Universal Consol.	4,173	3,753	—10	1,721	1,227	— 29
Wilcox Oil	3,806	2,830	— 2	422	446	+ 6
TOTALS	15,912,682	16,354,540	+2.8%	1,390,924	1,408,345	+1.3%

[1]Fiscal yr. ending May 31
[2]Nine months ending May 31
[3]Six months ending March 31
[4]Plus non-recurring profit of $3,409,000 from sale of assets
[5]Fiscal year ending March 31

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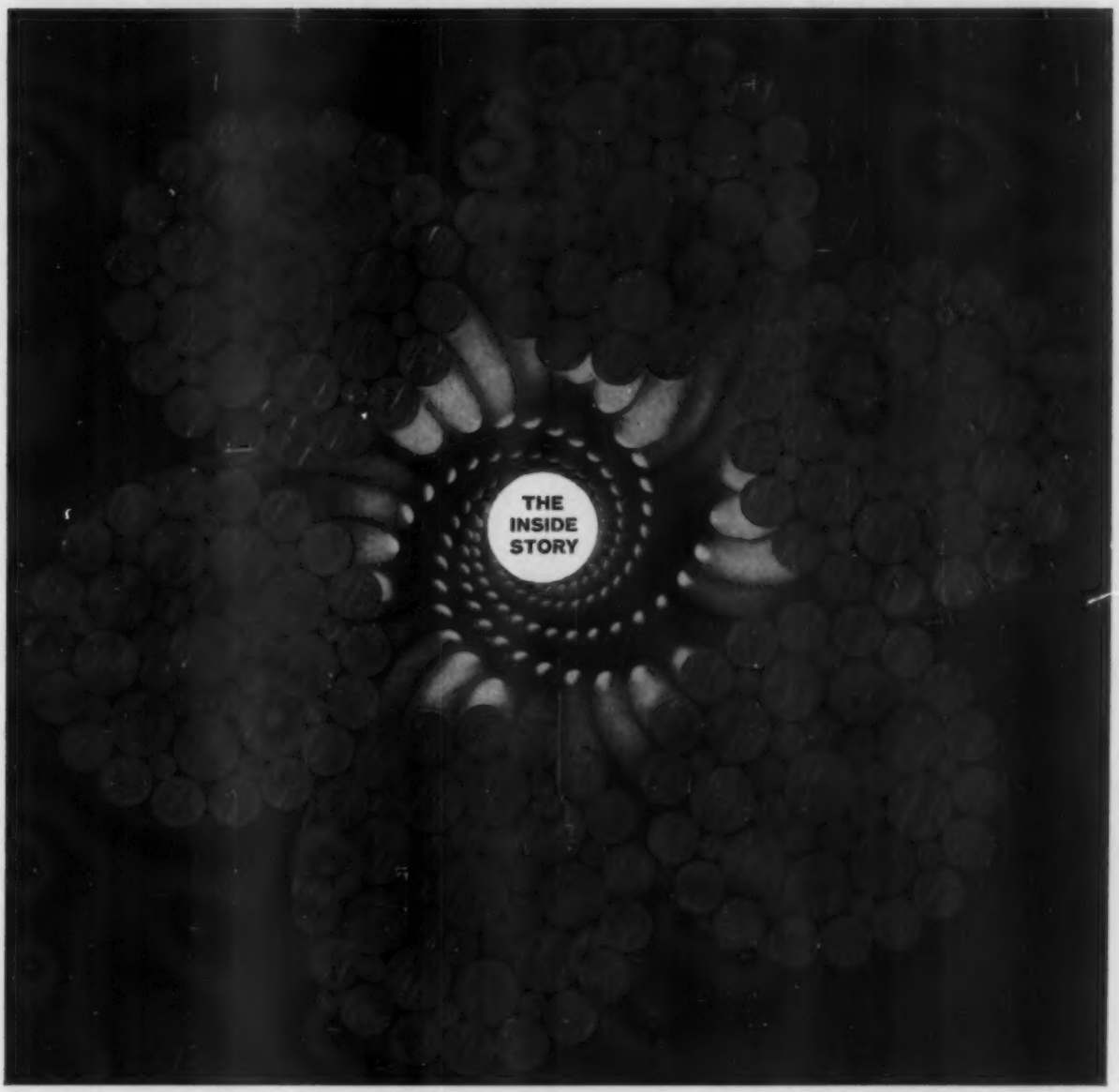

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GEORGE W. AYERS,
senior research associate

GLENN A. MARSH,
research associate

SCIENTISTS AND ENGINEERS can move ahead without being administrators in a revised personnel system at Pure Oil's Research Center.

"There are gifted men within our organization whose primary interest is creative research," Hugh L. Hemmingway, director of research, explained. "The revised system gives them an opportunity to advance in salary and in title other than by the usual route of assuming administrative responsibility.

"The system emphasizes the importance of the individual research worker in overall research effort. It is designed to develop an alert and aggressive organization composed of men with superior ability with this ability being suitably rewarded."

Professional personnel at the Center at Crystal Lake, Illinois, can progress on a merit basis to positions of increased responsibility by one of three routes: (1) supervisory or administrative, (2) scientific, and (3) technical specialist.

Supervisory top positions are: (1) group supervisor, (2) section supervisor, (3) division director, (4) assistant director of research or assistant manager, and (5) director of research or manager of the Research Center.

Scientific: (1) research scientist, (2) senior research scientist, (3) research associate, (4) senior research associate, (5) research consultant.

Technical specialists: (1) technologist, (2) senior technologist, (3) technical specialist, (4) senior technical specialist, (5) technical consultant.

Discussing the three routes to higher positions, Mr. Hemmingway said: "The supervisory route is the normal progression found in the business world. In research this group bears the responsibility for research results, attempts to provide encouraging climate for creative and productive research or service, and has responsibility for co-ordinating the overall research effort. Most of our supervisory group began their careers in research, and most have distinguished research records. As their administrative duties have increased, they have had less and less time to devote to actual research activity.

"In the revised research organization, the scientific or research route is open to those whose principal interest is the creative application of scientific knowledge to the company's objectives. Research scientists in this category will have the opportunity to select those activities which most closely coincide with their interests, talents, and professional aspirations, consistent with the needs and objectives of the company.

"The technical specialist ladder provides a means of advancement for scientists and engineers who develop a special knowledge of a particular field and function as full-time consultants or technical specialists. They may be engineers, mathematicians, petrochemical specialists, patent specialists, geologists, geophysicists, and those engaged in product evaluation or development. They provide guidance, counsel, and the performance of specific projects for both the scientific and administrative groups as well as for the company's operating divisions."

Dr. George W. Ayers became senior research associate, the highest nomination thus far on the scientific route and equivalent to the administrative position of assistant director of research.

Dr. Ayers' 34-year career with Pure parallels and almost spans the company's entire research effort which began in 1923. He has achieved distinction in organic synthesis and research and has been granted over 50 patents. Dr. Ayers received his PhD in chemistry from the University of Chicago. When he joined Pure in 1926, he was one of nine research workers employed by the company.

Glenn A. Marsh was made research associate. Head of the Center's corrosion section, he joined Pure in 1948 after receiving an MS in chemistry from Northwestern University. In 1958 he received the Young Authors Award of National Association of Corrosion Engineers.

Other scientific assignments are: senior research scientist, Dr. J. M. Parks Jr., and research scientists, Dr. G. D. Brunton, Dr. G. W. Crosby, W. L. Fierce, Dr. D. L. Klass and Dr. Walter E. Kramer.

Appointments in the technical specialist category are: Dr. R. T. Bell, Kenneth Boldt, and C. A. Porter, technical specialists; W. G. Annable, G. W. Simmons, and Dr. B. B. Woertz, senior technologist; W. J. Alford, W. T. Berg, Dr. H. A. Lindahl, F. L. Mueller, P. E. Pfeiffer Jr., and D. G. Samuelson, technologist.

Named to administrative posts are: E. W. Brennan, Dr. H. O. Folkins, H. Hennig, L. W. Holm, A. Manteuffel, Dr. Carel Otte, Dr. H. A. Slack, and Dr. K. P. Yates, section supervisors; A. J. Ackerman, Dr. J. M. Fraser, R. G. Moyer and A. W. Percy, group supervisors. ★ ★ ★

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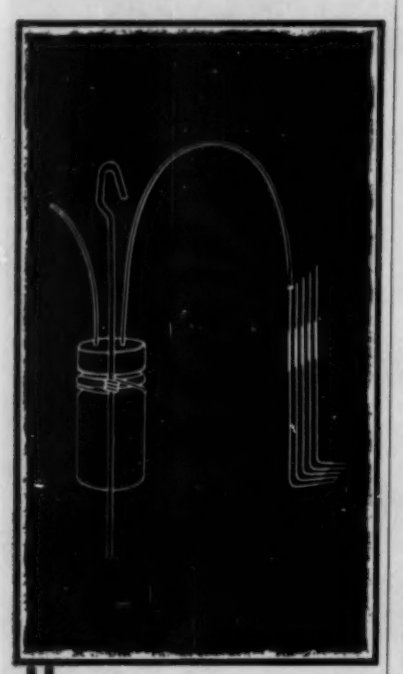

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EGGHEAD or SAVIOR?

Which is the engineer? According to this writer, he must be politician, executive, professional engineer, plain citizen. . . . It's quite a calling.

Kermit C. Cress

HISTORY OF THE GROWTH of America is essentially a history of its engineering achievements and applications of scientific discoveries to the creation of consumer goods and services. Our tremendous economic growth and prosperity is a direct result of these applications by our engineers.

Not only has American creative engineering made us the greatest industrialized and wealthiest nation of the world, but it has equipped us with the necessary weapons to fight several major wars and has provided us with the power to protect ourselves against aggression.

Today this country faces a challenge — basically it is a challenge to the ability and creativity of its professional engineers. Their position in government was recently dealt a blow. Their influence on national policy receded despite their technological achievements. Their short-comings — actually caused by restrictions of short-sighted government administration — became the focus of public attention after Sputnik.

America is faced with an elementary need for those tools which will insure our survival in the face of Russian advances in science and technology. Engineers and scientists must supply them.

Our needs are much broader than "missiles" alone. Our needs are: Improved science and engineering appreciation, education, and application. The fundamental defect in the present situation stems not from the lack of capable and willing engineers and scientists, but from previous failures to comprehend the problems this area of advanced technology has imposed on our civilization.

To administer the programs necessary for our survival, engineers and scientists must prepare themselves to be tomorrow's leaders. Their self-governed efforts are the only hope for our ultimate survival. To date, their prestige and authority have been less than impressive.

For the engineer, the existing situation is humiliating and frustrating. He can't enter politics to promote his profession. Industry considers him an implement for the creation of capital wealth; the layman thinks of him as an "egghead"; the military tolerates him only as a necessary evil to develop weapons. Between the engineer and the government there stands an almost indescribable labyrinth of bureaucracy. Rarely is the engineer accepted into the councils of policy-making that shape national decisions.

Root of the difficulty is in the system which places the military in close control of so much scientific research and development. The military has a long history of rigid tradition and inter-service rivalry, which produces a discouraging lack of imagination in scientific matters. Forty percent of all American creative scientific manpower, roughly ninety thousand persons, is entangled in this maze of government and military engineering. Government administration is never as efficient as its industrial counterparts.

Now, as never before, the engineer must recognize these national problems as personal challenges. He must take the initiative to prepare himself to be a practical politician, statesman, advisor on national affairs, and business executive; yet he must retain his identity as an average citizen. He must morally and ethically promote his profession.

Today's engineers and scientists, whether as advisors or payroll employees, must try to influence American national policy. Their influence is necessary for this country's continued prosperity and security. They must seek to weld science and government into a harmonizing structure. A means of creating a government-science partnership must be found. ★ ★ ★

Published in The Georgia Tech Engineer; written by a senior who believes the country's welfare rests with its engineers.

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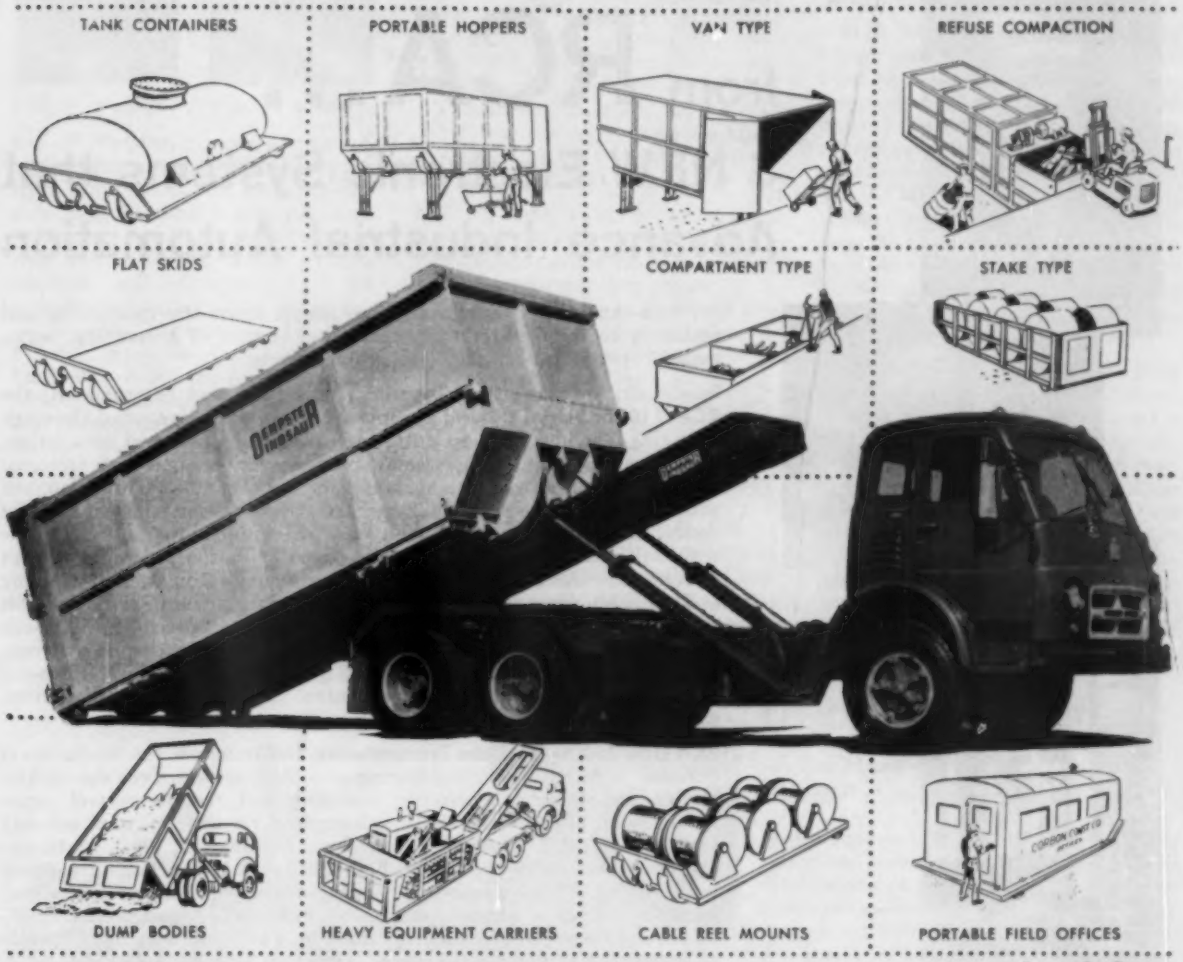

Patents Pending

Here's the materials handling tool that takes up where the fork-lift truck leaves off. Gigantic loads can be placed on skids, in tanks or containers. The DEMPSTER-DINOSAUR picks them up . . . automatically . . . in seconds . . . and whisks them to their destination, in-plant or to over-the-road locations. Here they are put down, intact . . . pushed off on a dock . . . left on telescopic legs . . . or dumped.

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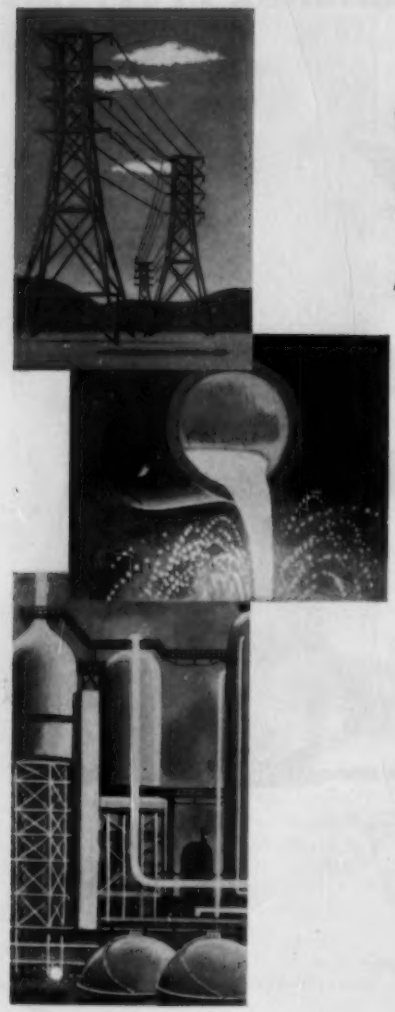
RCA-110 Industrial Control Computer
RCA-130 Industrial Data Transmission Link
RCA-150 Industrial Data Analyzer and Recorder



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...with capabilities that range from simple automatic monitoring and recording to complete real-time computer control of a complex "automated" operation over a wide geographical area.

Specifically designed for industrial applications and environment, the **RCA-110 Industrial Control Computer System** provides around-the-clock operating reliability, highest arithmetic speed and lowest cost installation. One megacycle, solid state circuits are conservatively operated. Optional sizes of random access core memories for working storage are combined with magnetic drums for bulk storage to provide greatest speed and desired memory size at reasonable cost. All options program-compatible with each. Easily expansible in field. Automatic priority program interrupt increases operating efficiency, permits continuous automatic self checking and enhances programming ease. Accepts binary or decimal data. 24 bit word length. One or two address. Seven index registers. Seventy-one instructions. Addition time, including access—56 microseconds. Strong, dust-tight, industrial housings are internally air conditioned. Slide-out chassis and built-in maintenance control panel permits fast front-of-cabinet maintenance.

RCA-130 Industrial Data Transmission Link removes the limitation of distance in an automatic monitoring or control system. Provides reliable on-line, real-time, telemetering, alarming and remote control signal transmission of analog or digital information via wire or radio, one-way or two-way. 100% parity check of digital information. 100% continuity check of communications circuit. Frequency shift tone keying. Frequency multiplexing or time sharing of channel as desired. Remote reports may be self-initiating or centrally sequenced. Low power requirements. Application engineered from standardized modules to completely fulfill specific requirements at minimum expense. Operates with RCA-110, RCA-150, or custom display and supervisory operating console.

High-speed, automatic monitoring and analysis of process and production status is provided by the **RCA-150 Industrial Data Analysis and Recording System**—plus computational capability for summarizing, averaging, totalizing and linearizing. Automatic alarms of process malfunctions. Accepts up to hundreds of inputs at a rate up to 1,000 points per second, with programmed or sequential scanning. Provides outputs for display panel, punched paper tape and typewriter, with provision for automatic standby. Display log format and speed to purchaser's specification. Internal, analog-to-digital conversion. All solid state circuitry, packaged for industrial environment, with optional internal air conditioning.

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Management Personals

V. W. Fletcher

G. F. Bassler

▸ **V. W. Fletcher,** manager of materials and purchasing agent for Asiatic Petroleum Corporation, was elected to succeed **S. J. Veenstra** as vice president. He assumes the responsibility for Materials Administration, which includes operation and administration of the materials purchasing, traffic and technical service department. In 1926, Fletcher began his Shell career with Caribbean Petroleum Company and served in Venezuela, Colombia, Ecuador, Borneo, and the United Kingdom. Fletcher joined Asiatic in 1950.

▸ **G. F. Bassler,** Houston, was promoted to the newly created position of assistant to the general manager of manufacturing for Continental Oil Company (Panama operations). Formerly director of personnel development, Bassler will continue to make his headquarters in Houston. He will assist **D. R. Johnson,** vice president and general manager, manufacturing department, and the management of Refineria Panama, S. A., on personnel and industrial relations matters in organizing, staffing and operating the company's $30,000,000 refinery now under construction in the Republic of Panama. Refineria Panama, S. A., is owned jointly by a wholly owned subsidiary of Continental Oil Company and interests of National Bulk Carriers, Inc.

▸ **C. M. Janes,** supervisor of Ohio Oil Company's procedures research department, was appointed manager of procedures research and data processing division. Jane succeeds **D. R. Mason** who is entering the consulting business. **M. H. Reamsnyder,** presently supervisor of the Marathon Pipe Line Company accounting department, follows Janes, and **W. S. Deppen,** assistant supervisor of refining and marketing accounting department, assumes Reamsynder's duties.

▸ **D. E. Anderson** and **C. E. Cole** of Calgary were chosen vice presidents of Canada-Cities Service Petroleum Corp. As vice president, Anderson continues his present duties as manager of operations. Cole, vice president and exploration manager, directs the exploration program of Canada-Cities Service.

▸ **Walter F. Baleiko, M.D.,** formerly with Crane Company, joined Standard Oil Company (Indiana) as staff physician in the general office medical department.

▸ **H. B. Brown** was elected an administrative vice president of Gulf Oil and appointed coordinator-transportation, responsible for coordination of all methods Gulf uses to transport crude oil and petroleum products. A 10-year veteran with Gulf, Brown succeeds **R. D. McGranahan,** who recently resigned to become president of Wilshire Oil Company of California. **S. G. Sanderson,** vice president of Gulf Oil at Houston, retired August 1. **C. D. Cordry,** division exploration coordinator at Fort Worth, has also retired.

▸ **Marshall McDonald,** vice president and financial coordinator of Sinclair Oil & Gas Company, was elected a member of the board of directors. **Floyd Brett,** vice president and manager of the central division for Sinclair Oil & Gas Company, Tulsa, Okla., was elected executive vice president of Sinclair Canada Oil. Brett moves to Calgary, **Walter P. Wilson** continues as vice president and manager of explo-

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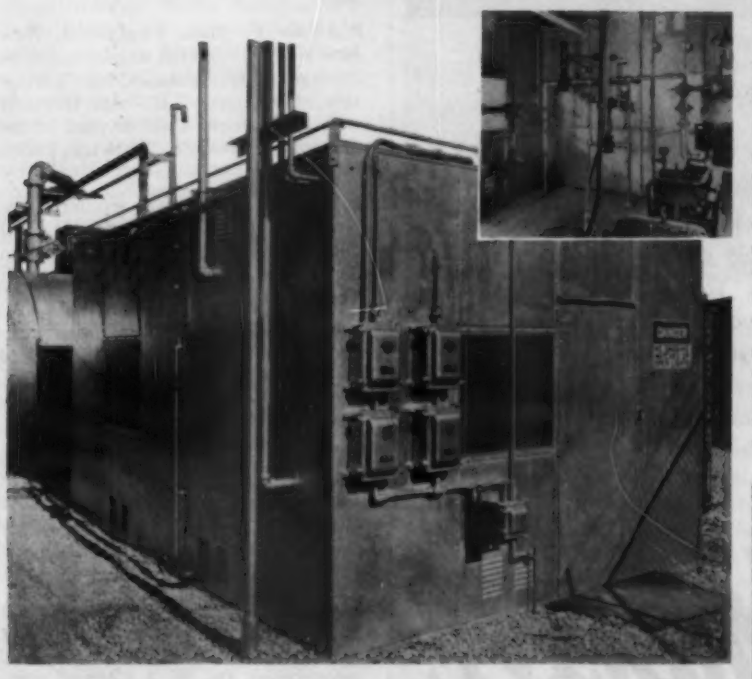

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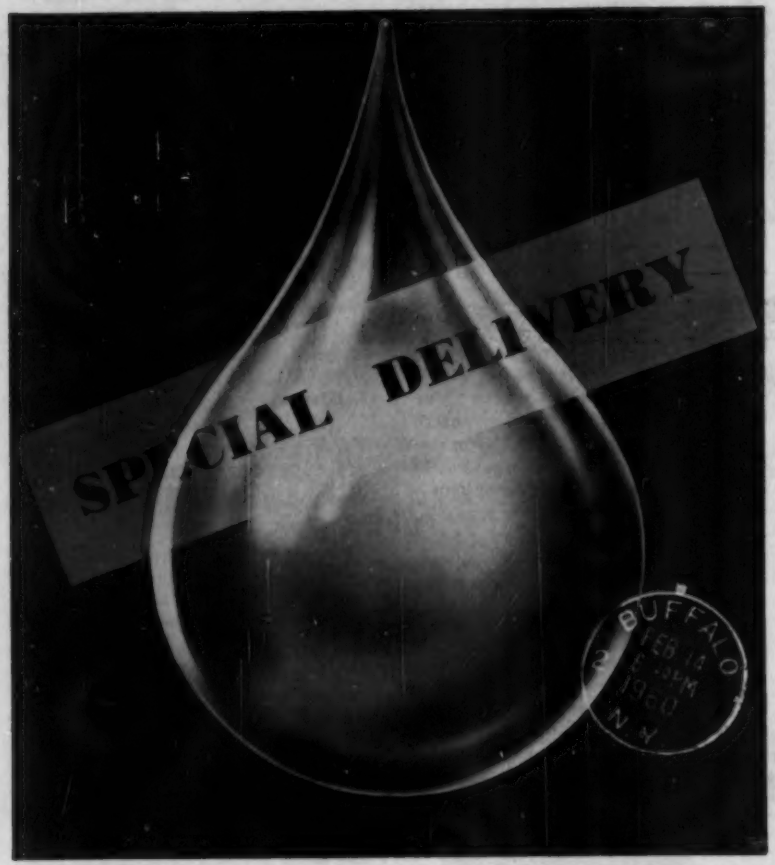

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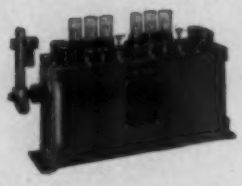

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ration for Sinclair Canada. **Joseph B. Kennedy,** executive vice president for operations, and **M. M. Shumard,** comptroller, were elected to Sinclair Canada's board of directors.

▸ **George F. Kelly** became sales engineer in the New York City district offices of the Industrial Silencer Division of Burgess-Manning Company. He formerly served as a procurement engineer for the Welding Shipyard Division of National Bulk Carriers.

▸ **Paul C. Wallack,** formerly president of Walco Engineering and Construction Company; **Marvin E. Fox,** a Walco vice president in charge of engineering; **Parker H. Capps,** a vice president and secretary-treasurer of Walco, and **R. W. Wire,** past president of Loffland Brothers Company, have joined forces in a new business concerning engineering, construction, and management activities for the petroleum industry and allied fields.

▸ **Martin A. Row** takes the newly-created position of counsel for regulatory and natural gas matters for Sun Oil Company. **Charles F. Heidrick,** assistant general attorney, succeeds Row as general attorney for Sun's Southwest production division. Row, who will remain in Dallas in his new position, has been a member of Sun Oil's legal staff for almost 30 years. Before returning to college in 1928 to complete his law studies, he had almost four years experience as a scout and landman for Sun.

▸ **Austin F. Platt,** Englewood, New Jersey, was promoted to national sales manager of Hydromatics, Inc., Livingston, New Jersey. He was formerly with the Hammel-Dahl division of the General Controls Co., Warwick, Rhode Island.

▸ **W. Ward Kemper** was appointed employee relations coordinator for Gulf Oil Corporation's domestic production department, replacing Herman E. Teale, deceased.

▸ **Jackson Kemper,** formerly vice president and general manager of forge and fittings division of H. K. Porter Co., Inc., was appointed executive vice president of Mueller Co.

▸ **Jack C. Hardy Jr.,** a member of Sun Oil Company's legal staff, was named assistant general attorney for Sun's Gulf Coast production division. Hardy succeeds **Charles F. Heidrick,** general attorney for Sun's Southwest division.

▸ In Texaco's research and technical department reorganization the following managers were named: planning and information, **Dr. W. J. Coppoc;** commercial development — products, **Patrick J. Keating Jr.;** commercial development — processes, **John K. McKin-**

ley; technical services, **W. A. McMillan,** and administrative services, **Dr. Richard L. Sawyer. Russell W. Hall** is manager for the department and coordinates the department's activities with the refining department's.

Texaco's largest research laboratories managers are responsible to the general manager. They are: Beacon, N. Y. laboratories, **Dr. Robert E. Conary;** Bellaire, Texas, Laboratories, **Dr. Gerhard Herzog,** and Port Arthur-Port Neches, Texas, laboratories, **Hyman D. Massin. Dubois Eastman,** director, heads Texaco Research Laboratory, Montebello, California, and is responsible to the general manager.

▸ Standard Oil Company (Indiana) releases concerning posts after its reorganization January first include: **John E. Swearingen** will continue as president and become chief executive officer after **Frank O. Prior** retires and the office of chairman is discontinued. **Robert C. Gunness** continues as an executive vice president and will coordinate activities of three affiliates, American Oil, Amoco Chemicals, and Tuloma Gas Products. **George V. Myers** remains an executive vice president and will coordinate activities of four affiliated companies, Pan American Petroleum, Service Pipe Line, Indiana Oil Purchasing, and Amoco Trading. Under Myers' direction are to be **John R. Evans,** general manager of production, responsible for coordinating crude oil production, pipeline, and purchasing activities in North America, and **F. H. Blunck,** coordinator of foreign operations. **S. A. Montgomery** stays as a vice president, reporting to Gunness and coordinating manufacturing, research, and purchasing functions. Reporting to Montgomery are **P. C. Livesay,** deputy coordinator of manufacturing; **S. B. Schapiro,** deputy coordinator of engineering and construction; **R. A. Steel,** deputy coordinator of research and development; **L. E. Schaffer,** deputy coordinator of purchasing, and **L. J. Frodin,** deputy coordinator of administration and organization planning.

Dwight F. Benton, vice president of sales, will coordinate marketing, supply, and distribution functions. He also reports to Gunness. **A. K. Smith,** coordinator of marketing, supply and distribution; **C. R. Wolf,** deputy coordinator of marketing, and **B. J. Yarrington,** deputy coordinator of administration, will report to Benton.

David Graham remains financial vice president. Reporting to him are to be **W. A. Underwood,** comptroller; **J. F. Goetten,** manager of tax department, and **C. Henry Austin,** manager of the insurance department. **J. Howell Turner** remains general manager of employee and public relations. Reporting to him will be **Don Campbell,** director of public relations; **F. Roe Weise,** director of employee relations; and **R. F. Baldaste,** director of organization planning. **Merwin Bristol** continues as general counsel. Answering to him will be **E. L. Godshalk,** assistant general counsel, and **W. W. Spear,** senior attorney. **Earl W. Russell** remains as corporate secretary. **S. K. Botsford, P. C. Jensen,** and **M. L. Hayes** will be assistant secretaries. Botsford and Hayes will also be administrative assistants to the president.

L. W. Moore continues as president and chief executive officer of American Oil Company. Reporting to him will be the department heads of the administration, law, employee and public relations, and research and development departments.

In the employee and public relations department: **C. W. Cougias,** manager of personnel relations; **J. R. Glennon,** manager of employee relations research; **R. H. Foster,** manager of labor relations; **W. O. Wilson,** manager of safety, and **G. H. Collings, M.D.,** medical director, will report to **R. O. Traylor,** director of employee relations. **H. H. Hardy,** manager of field services; **John Canning,** manager of information services, and **W. P. Schoentgen,** man-

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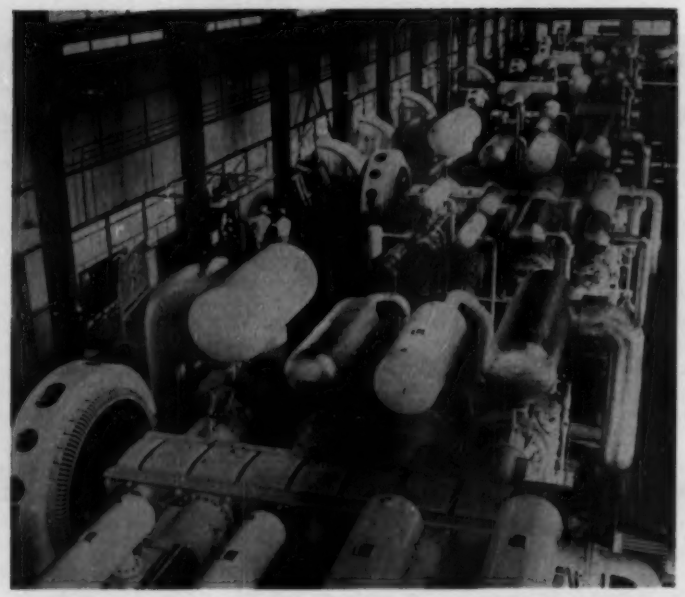

Petroleum Chemicals, Inc., Installs 98 Burgess-Manning Snubbers To Prevent Pulsation Damage In New Ammonia Plant

Foster Wheeler Corporation was contracted by Petroleum Chemicals, Inc., to design and construct a multi-million dollar ammonia process plant at Lake Charles.

Realizing that gas pulsation would cause severe operating problems in the multi-service process piping related to reciprocating compressors, and that hazardous pulsation should be engineered out of the plant in the initial design, Foster Wheeler called upon Burgess-Manning Company to develop pulsation snubbers for various service conditions and for installation under the original contract.

Ninety-eight pulsation snubbers of 46 individual designs were installed on multi-stage, multi-service compressors. The snubbers were installed on both the suction and discharge sides of the compressor cylinders in what is believed to be *the largest single installation of pulsation snubbers under one roof.*

The compressors handle various types of gases, ranging in molecular weight from 5.13 to 33, at pressures from atmospheric to 9,270 P.S.I.A.; and at discharge temperatures to 350° F. Under these exacting conditions, Burgess-Manning accepted the responsibility to engineer and supply pulsation snubbers of optimum design that would: *1. Hold the pulse amplitude to 2 per cent or less, total surge peak-to-peak, of absolute line pressure, and 2. hold a minimum pressure drop requirement.*

The snubbers were subjected to the stringent specifications of material, workmanship, and inspection procedures normally followed by Foster Wheeler in process plants of this type. All forged snubbers for high-pressure service were made of high tensile alloy steel. Internal assemblies were engineered to withstand extreme forces.

After the plant went on stream, operational inspection revealed minimum pulsation-induced vibration, eliminating operating hazards, constant maintenance, and upkeep of the laterals, headers, intercoolers, and separators attendant to the snubbers.

If you are planning a new plant, or have a pulsation problem in your present plant, it will pay you to consult Burgess-Manning — "The Sound Engineering People." There's no obligation, of course.

Industrial Silencer Division
BURGESS-MANNING COMPANY
The Sound Engineering People 9241 SOVEREIGN ROW • DALLAS 7
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ager of creative services, will be under **J. M. Patterson,** director of public relations. **P. F. Miller,** director of organization planning, Traylor and Patterson will report to **Winston S. Peeler,** vice president of manufacturing, forthcoming general manager of employee and public relations.

Standard Oil (Indiana), American, and Utah Oil Refining companies' departments of research and development were consolidated earlier this year. **A. A. O'Kelly,** director of petroleum research and development; **W. E. Kennel,** director of chemical research; **R. B. Jacobs,** director of engineering research, and **E. W. Adams,** director of administration, report to **A. P. Lien,** manager of research and development. **E. L. d'Ouville,** director of information and communication; **Robert Gottschalk,** director of contracts and legal matters; **A. G. Gilkes,** general patent attorney, and **R. C. Arnold,** director of licensing, are under **P. H. Sullivan,** manager of patents and licensing. **J. B. Duckworth,** coordinator of products; **Nathan Fragen,** coordinator of commercial development and contract research; **J. E. Seebold,** coordinator of process development, engineering, and administration; Dr. Lien, and Sullivan report to **Philip C. White,** general manager of research and development.

F. Cushing Smith, general manager of supply and transportation for Standard Oil Co. (Indiana), American's future executive vice president, will receive reports from the manufacturing, supply and transportation departments. In the manufacturing department: **A. G. Clark,** assistant manager of operations, and **C. Feuchter,** assistant manager of costs, will report to **R. M. Cash,** manager of operations. **G. W. Keranen,** manager of general engineering, and **T. A. Abbott,** manager of engineering and technical service administration, are to report to **F. W. Scheineman,** director of engineering. **R. S. McDaniel,** assistant manager of process planning, and **F. Curtis Smith,** assistant manager of capital expenditure planning, will be under **A. H. Hayes,** manager of planning. **L. H. Butterworth,** manager of refineries, and **W. T. Herget,** director of technical service, Cash, Scheineman, and Hayes will report to **J. C. Ducommun,** general manager of manufacturing for Standard Oil, the next vice president of manufacturing for American.

In the supply and transportation department: **C. F. Gearhart,** manager of transportation; **W. A. Bennett,** manager of distribution, and **L. W. Ewing,** manager of engineering, will report to **S. L. Jackson,** manager of operations. **W. H. Scott,** manager of construction and equipment purchases; **R. E. Bauman,** manager of supply purchases; **G.**

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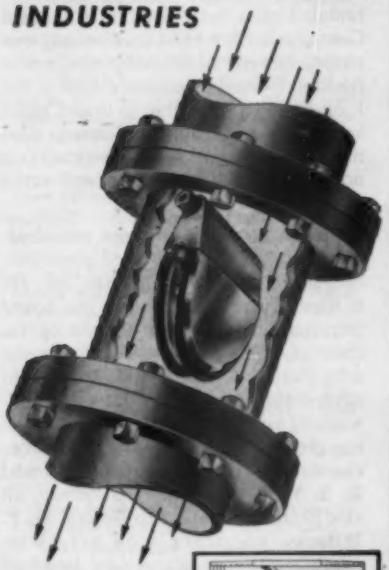

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M. Brady, manager of field purchases; and **C. E. Anderson,** manager of purchase planning, are to report to **Charles F. Smith,** director of purchases. **W. R. Remalia,** manager of product supply; **W. E. McGinnity,** manager of economic analysis, and **J. J. Svoboda,** manager of crude oil coordination, will report to **H. A. Parker** manager of coordination and supply planning. **P. R. Gary,** manager of highway division; **L. F. Andry,** manager of rail division, and **G. E. Mayfield,** manager of general traffic division, are to report to **R. L. Andreas,** manager of traffic. **C. D. Phillips,** manager of operations; **W. G. Bolger,** manager of administration and transportation and, **D. M. Brewer,** manager of maintenance and repair, will be under **T. M. McQuilling,** manager of marine operations-ocean tankers. Jackson, Charles F. Smith, Parker, Andreas, and McQuilling will report to **John E. Kasch,** vice president-administration, the future general manager of supply and transportation.

B. J. Duffy, supervisor of planning, and **R. F. Stahl,** supervisor of operations and economics, will report to **P. C. Livesay,** deputy coordinator of manufacturing. **V. R. West,** manager of press relations, and **R. C. Siebert,** manager of creative services, are to report to **Don Campbell,** director of public relations. **E. W. Ahern,** personnel depelopment consultant, and **E. F. Paul,** salary consultant, will be under **R. F. Baldaste,** director of organization planning for employee and public relations.

In financial activities **J. H. Galligan** and **O. E. Wachholz,** assistant comptrollers, are to report to **W. A. Underwood,** comptroller. **T. W. Brown,** assistant to the secretary, and **W. R. Brodine,** chief pilot, will report to **Earl W. Russell,** corporate secretary of the secretary's department.

American Oil Company will become the single marketing, refining, distribution, and product research subsidiary of Standard Oil Company (Indiana), subject to Internal Revenue Service clearance and stockholder approval.

▸ **James K. Wootan,** director of exploration, and **E. Paul Ludman,** treasurer, were named vice president in charge of exploration and vice president respectively of Signal Oil and Gas Company.

▸ **Dr. Alexander Lewis Jr.** was elected a vice president of Gulf Oil Corporation. Formerly manager, petrochemicals department, Dr. Lewis continues to direct Gulf's petrochemical interests.

▸ **Ernest H. Rettig,** formerly technical representative in project engineering and pipeline construction for El Paso Natural Gas Co., was named the first full time sales and service representative for South America of Grove Valve and Regulator Company.

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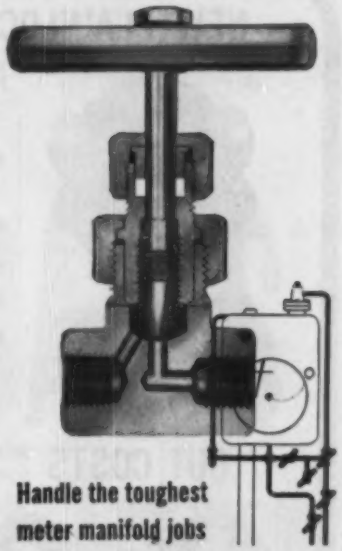

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▸ Named by presidential decree as director of Petrobras, Brazil's oil entity, was **Professor Manoel Pinto de Aguiar,** well-known economist and former Secretary of Finances of the municipality of Salvador. He replaces **Decio Saverio Oddone,** retired. **General Idalio Sardenberg** is president of Petrobras.

▸ **H. M. Bayer,** vice president at Fort Worth, of Gulf Oil Corporation, retired August 1.

▸ **L. D. Sullivan,** director of Lion-branded sales for Monsanto Chemical Company's Lion Oil Co. division, was named director of branded sales, a new position formed by consolidation of the Lion-branded and private-brand retail sales sections. **Frank C. Graves,** sales manager of Lion-branded products, is now manager of private-brand retail sales.

▸ **I. John Billera,** senior vice president, was elected executive vice president-operations of U. S. Industries, Inc. He is directly responsible to the board chairman and president for the operations of USI's thirteen divisions and subsidiaries. **R. D. O'Brien,** oil field equipment group; **C. J. Plisky,** metal-working equipment and metal fabricating group; **E. F. Shelley,** automation, electronics and research group, and **R. S. Wright,** international group, all vice presidents, report to Billera. **W. F. Wilmas,** executive vice president-administration, continues to direct all administrative activities.

▸ **A. J. Senec** retired as manager of Tidewater Oil Company's eastern division economics department.

Deaths

▸ **Roy M. Johnson,** 79, died of cancer July 30. Mr. Johnson was one of the principal discoverers of the Healdton, Fox, Graham, and Empire oil fields of southern Oklahoma and the Ranger and Burkburnett fields in north Texas. A "Profile" of Mr. Johnson in Petroleum Engineer for March, 1955 gave briefly his colorful career and extensive philanthropies.

▸ **Harry N. Strothman,** 42, Chicago regional sales manager for Royston Laboratories, Inc. of Blawnox (Pittsburgh) Pennsylvania, died at his Park Forest, Illinois home, July 7.

▸ **William J. Stebler,** 57, an assistant to the chairman of the board and a director of General American Transportation Corp. also the past president, died at Evanston, Illinois, after a brief illness.

▸ **Dr. Saul R. Buc,** 45, research fellow at Central Research Laboratories, General Aniline & Film Corporation, Easton, Pennsylvania, died June 5 in New York City.

Meetings . . .

Sept. 18-21 — **American Society of Mechanical Engineers**, petroleum mechanical engineering conference, Jung Hotel, New Orleans, La.

Sept. 19-21 — **Texas Mid-Continent Oil & Gas Assn.**, annual meeting, San Antonio, Texas.

Sept. 20-21 — **Illinois Oil Industry** convention, St. Nicholas Hotel, Springfield, Ill.

Sept. 20-21 — **Water Lift Institute**, Court House, Liberal, Kans.

Sept. 20-21 — **American Gas Assn.**, organization meetings, Hotel Cleveland, Cleveland, Ohio.

Sept. 23-24 — **Assn. of Desk & Derrick Clubs**, annual convention, Sheraton-Cadillac Hotel, Detroit, Mich.

Sept. 25-27 — **American Assn. of Oilwell Drilling Contractors**, annual meeting, Roosevelt Hotel, New Orleans, La.

Sept. 25-28 — **American Institute of Electrical Engineers**, petroleum industry committee, Hotel Skirvin, Oklahoma City, Okla.

Sept. 26-29 — **American Welding Society**, national fall meeting, Hotel Penn-Sheraton, Pittsburgh, Pa.

Sept. 26-30 — **ISA**, Instrument-Automation Conference and Exhibit and ISA's 15th annual meet, New York Coliseum, New York City.

Sept. 27-28 — **API Executive Committee of Board of Directors**, The Greenbrier, White Sulphur Springs, W. Va.

Sept. 28-30 — **Mid-Continent Oil and Gas Assn.**, Miss.-Ala. division meeting, Grand Hotel, Point Clear, Ala.

Sept. 29-30 — **Mid-Continent Oil & Gas Assn.**, Mississippi-Alabama division meeting, Grand Hotel, Point Clear, Ala.

Oct. 2-5 — **Society of Petroleum Engineers of AIME**, annual fall meeting, Denver, Colo.

Oct. 3-4 — **Independent Natural Gas Assn. of America**, annual meeting, Fontainebleau Hotel, Miami Beach, Fla.

Oct. 4-5 — **Gas Measurement Institute**, National Guard Armory, Liberal, Kansas.

Oct. 6-7 — **National Assn. of Corrosion Engineers**, annual Western region conference, Sheraton-Plaza Hotel, San Francisco, Calif.

Oct. 6-8 — **National Assn. of Corrosion Engineers**, Southeast region conference, Dinkler-Plaza Hotel, Atlanta, Ga.

Oct. 9-13 — **ASTM**, Committee D-2 meeting, Mayflower Hotel, Washington, D. C.

Oct. 10-12 — **American Gas Assn.**, annual convention, Atlantic City, N. J.

Oct. 11-14 — **National Assn. of Corrosion Engineers**, Northeast region conference, Prichard Hotel, Huntington, W. Va.

Oct. 12-14 — **Southwest Federation of Geological Societies**, annual meeting, Abilene, Tex.

Oct. 13-14 — **California Natural Gasoline Assn.**, annual fall meeting, Hotel Miramar, Santa Monica, Calif.

Oct. 17-19 — **Production Drilling & Blasting Symposium**, 10th annual, Colorado School of Mines, Golden, Colorado.

Oct. 19-20 — **National Assn. of Corrosion Engineers**, North Central region conference, Schroeder Hotel, Milwaukee, Wis.

Oct. 19-21 — **Rocky Mountain Oil and Gas Assn.**, annual convention, Brown Palace Hotel, Denver, Colo.

Oct. 20-21 — **Society of Petroleum Engineers of AIME**, Los Angeles Basin section, Huntington-Sheraton Hotel, Pasadena, Calif.

Oct. 23-25 — **Independent Petroleum Assn. of America**, annual meeting, Statler-Hilton Hotel, Dallas, Tex.

Oct. 23-25 — **Pennsylvania's Petroleum Assn.**, Management Institute, Penn State University, University Park, Pa..

Oct. 23-26 — **North American Gasoline Tax Conference**, LaSalle Hotel, Chicago, Ill.

Oct. 25-27 — **American Standards Assn.**, 11th National Conference on Standards, Sheraton-McAlpin Hotel, New York City.

Oct. 25-28 — **National Assn. of Corrosion Engineers**, South Central region conference, Mayo Hotel, Tulsa, Okla.

Oct. 26-27 — **WPRA**, Refining Technology, Rufus Garrett Hotel, El Dorado, Ark.

Oct. 28 — **Natural Gasoline Assn. of America**, Southern regional meeting, Carlton Hotel, Tyler, Texas

Oct. 31-Nov. 1 — **National Lubricating Grease Institute**, annual meeting, Edgewater Beach Hotel, Chicago, Ill.

Nov. 3-4 — **Society of Automotive Engineers**, national fuels and lubricants, Mayo Hotel, Tulsa, Okla.

Nov. 3-4 — **AAPG**, Pacific Section, annual meeting, Ambassador Hotel, Los Angeles, Calif.

Nov. 7-10 — **SEG**, 30th annual international meeting, Moody Convention Center, Galveston, Tex.

Nov. 14-16 — **Society of Petroleum Engineers of AIME**, Venezuelan sections, 4th annual meeting, Site unreported, Maracaibo, Venezuela.

Nov. 14-16 — **American Petroleum Institute**, annual meeting, Conrad Hilton, Palmer House and Congress hotels, Chicago, Ill.

Nov. 15-16 — **Natural Gas Pipeline Institute**, Court House, Liberal, Kans.

Nov. 18 — **Natural Gasoline Assn. of America**, Panhandle Plains regional meeting, Herring Hotel, Amarillo, Tex.

Nov. 27-Dec. 2 — **American Society of Mechanical Engineers**, annual winter meeting, Statler Hilton Hotel, New York, N. Y.

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Books To Read . . .

▸ **International Oil and Gas Developments, Part 1** *by International Oil Scouts Association, P. O. Box 1095, Austin 66, Texas, in Cooperation of the Society of Petroleum Engineers, AIME. 832 pages. Price, $25.00.*

Domestic exploration activities for 1959 are reported by oil scouts and individual contributors. Foreign developments last year are reported by the SPE-AIME. This 30th edition lists 11,922 exploratory wells in the U. S. accounting for a total of 63,192,493 ft of exploratory hole, along with operator's name, location, total depth and results. Also given is detailed information on each new field discovery, extensions and new pays for U. S., Canada and some foreign countries. Part 1, just released, shows the location and extent of nearly 18 million acres of drilling blocks assembled during 1959, and lists by county and company more than 20,000 crew-weeks of exploratory activity. One section lists 161 million acres of undeveloped land under lease, by company and county. Part 2 will be released in October.

"Employee Discipline" by Lawrence Stessin. *Published by The Bureau of National Affairs, Inc., 1231 24th Street, N. W., Washington 7, D.C., 309 pages. Price, $7.85.*

Employee discipline is the real drama of labor relations. Here are no small issues. For management, the stakes are nothing less than the right to control the operation in an orderly, efficient way. For the employee, the stakes are his job, his security, his seniority rights, and his status in the group.

For the company whose employees are not represented by a union, this book will provide many pointers for just dealing in the ever-present problem of employee discipline.

"Energy and Man," *A Symposium published by Appleton-Century-Crofts, 35 West 32 Street, New York 1, New York, 113 pages. Price, $3.75.*

This is a publication of papers presented November 4, 1959 at a symposium sponsored by Columbia's Graduate School of Business and the American Petroleum Institute as part of the Oil Centennial activities.

There are five interesting essays by eminent Americans. "Energy in the History of Western Man," by Allan Nevins, the great historian; "The Petroleum Revolution," by Robert G. Dunlop, president of Sun Oil Company, who plays a leading role in the industry's affairs; "Energy Patterns of the Future," by Edward Teller, now professor of physics at University of California and an outstanding scientist in the thermonuclear development; "Low-Cost and Abundant Energy," by Edward S. Mason, professor of economics at Harvard University, and the paper, "Energy and Public Affairs," by the distinguished son of a distinguished father, Herbert Hoover, Jr.

At the end of each paper are the questions of the audience and their answers by members of the panel. These contribute to the interest of the volume.

▸ **"The Roots of Capitalism"** *by John Chamberlain. Published by D. Van Nostrand Company, Inc., 120 Alexander St., Princeton, N. J., Pages 222. Price, $5.50.*

With the socialism vs free enterprise theme in the political campaign, the free enterprisers will get some solid material from "The Roots of Capitalism" by one of the foremost writers on conservative economic questions. He has been on *Fortune, Barron's* and now writes for the *Wall Street Journal.*

In the preface the author says that for many years the system we call capitalism was on the defensive. It existed in the here and now and its imperfections were plainly apparent to everybody. Socialism, on the other hand, was

something to be obtained in the future — a thing of shining colors wrapped in the gossamer tissue of a dream. Its imperfections were still concealed in the womb of time.

With the advent of socialist economies (Communist Russia and China) and the semi-socialist (Scandinavia, Britain, and New Deal America) capitalism can be compared on an equal basis with socialism. It may have its islands of proverty, its "contradictions," but "it does not murder people as a matter of policy or shut them up in concentration camps. It does not force men and women to accept uncongenial occupations or goods that are subjected to the approval of a small 'planning' bureaucracy. It does not reduce life to a continual round of abject permissiveness." Says John Chamberlain, "We have an affluent society because it has been free."

▸ **Specification Technique of Management** *by Robert R. Updegraff. Published by Executive Development Press, Inc., Littleton, New Hampshire. Pages, 62. Price, single copy $1.*

Object of the specification technique is to develop a strength and confidence that will aid in assuring the profits and progress of a business. Specifications are set for six basic types—project, problem, potentials, people, program and conference. This is one of the executive development series and can be purchased in quantities at less price.

▸ **"Eleventh Annual Institute on Oil and Gas Law and Taxation,"** *at Southwestern Legal Foundation, Dallas, Texas. Published by Matthew Bender and Company, Inc., 255 Orange St., Albany 1, N. Y. 683 pages. Price — $18.50.*

Southwestern Legal Foundation's annual institute on oil and gas law and taxation has contributed a great deal to the understanding of highly complicated legal puzzles in a complex business. The papers of the ninth annual institute, held in 1958, have been published and those of the tenth institute have gone to press. Simply giving the titles of the chapters will provide an idea of the extensive coverage:

How the Habendum Clause Is Affected by Other Clauses . . . James E. Sperling of Simms, Modrall, Seymour, Sperling and Roehl, Albuquerque.

Problems of the Common Purchaser, Pipe Line Proration and Market Demand . . . John Rogers, general counsel, Chapman-McFarlin Interests; Dean, School of Law, University of Tulsa.

Legal Problems of Water Flooding, Recycling and Other Secondary Operations . . . Oliver H. Hughes of Collins, Hughes, Martin & Pringle, Wichita.

Key Legal Aspects of Oil and Gas Financing . . . Hubert Dee Johnson of Carrington, Gowan, Johnson, Bromberg & Leeds, Dallas.

How Ratification, Adoption and Estoppel Affect Leases and Pooling Agreements . . . E. L. Brunini of Brunini, Everett, Grantham and Quin, Vicksburg.

Partition of Mineral Interest . . . Charles B. Wallace, vice president, Magnolia Petroleum, Dallas.

Consequences of Title Failure in Oil and Gas Transactions . . . John C. Jackson, formerly general atty., Texaco, Houston.

Re-examination of Doctrine of Development Covenants . . . Will Mann Richardson, attorney, Tyler.

Secondary Recovery Tax Problems . . . Donald P. Moyers of Logan, Moyers, Martin & Hull, Tulsa.

Tax Considerations of Foreign Operations . . . Walter Brudno, Research Staff, Harvard Law School; Editor, World Tax Series.

Tax Problems in Latin America . . . Ewell E. Murphy, Jr. of Baker, Botts, Andrews & Shepherd, Houston.

Collapsible Corporations — § 341 Problems . . . Russell K. Bolton, Jr. of Olwine, Connelly, Chase, O'Donnell & Weyher, New York.

Controlled Corporations Stock Distribution — § 355 Problems . . . Clifford L. Porter of Cahill, Gordon, Reindel & Ohl, New York.

Recent Developments Affecting Oil & Gas Transactions . . . Edward B. Benjamin, Jr. of Stone, Pigman & Benjamin, New Orleans.

The first 10 volumes are $18.50 per volume. Volume 1 to 10 plus the index is $155.

Robert A. Wilson, vice president and director of research for Southwestern Legal Foundation, is the general editor.

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Laugh with Barney

Little Dennis was having himself a ball on his first plane trip. He pushed every button in sight, ran through the aisles at top speed and finally crashed into the stewardess as he was serving a tray of coffee.

The stewardess picked herself up and grabbed young Dennis by the arm. "Son," she cooed sweetly, "why don't you go outside and play?"

Nobody gave the bride away, but several young men at the wedding could have if they had decided to talk.

An optimist is a guy who opens a pint in a crowd and saves the cork.

Letter to a soap company:

Gentlemen: Your soap is great! My mother-in-law fell on a cake and busted her jaw. Thanks.

Sign in bathroom in a local boarding house: Please Clean Tub After Bathing Landlady.

When a girl sneezes it is a sign that she is catching cold. When she yawns, it is a sign that she has gotten cold.

A man was on his way to visit some friends during summer vacation. The way led through a swamp.

"Say," he asked, "is it true that an alligator won't hurt you if you carry a torch?"

The guide thought a moment. "Depends on how fast you carry it, I reckon."

A white collar worker is one who carries his lunch in a brief case instead of a pail.

Jones: "I don't see why you haggle so over the price with the tailor about that suit; you'll never pay him anyhow."

Jakes: "But I'm conscientious; I don't want the poor fellow to lose more than necessary.

Wife: So you saw Mable downtown this afternoon? What kind of hat was she wearing?"

Husband: Don't know. Didn't notice. Too windy.

Second, "Well, old man, I'm afraid you're licked now."

Boxer (gazing dizzily across to opposite corner), "Yeah, I shoulda got him in the first round when he was alone."

"I'm not wealthy and I don't have a yacht and a convertible like Phillip Brown," apologized the suitor, "But darling I love you."

"And I love you," too, replied the girl, "But tell me more about Phillip."

A foreign diplomat was sitting next to a very beautiful blonde at a state dinner. During the dinner he put his hand under the table and started to feel her ankle. She gave him a bright smile. Encouraged, he went a little higher to the calf of her leg. Again the smile. With this additional encouragement, he went above the knees. Soon the blonde leaned over and whispered in his ear: "When you get far enough to discover I'm a man, don't change expressions. I'm secret agent number six."

The lady was stepping from the shower and was about to reach for a towel when she caught sight of a window washer taking in all of her charms. She was too stunned to move, just staring at the man.

"Whatcha lookin' at, lady," he finally asked. "Aincha never seen a window washer before?"

Smith was sitting down to breakfast one morning when he was astounded to see an announcement of his death in the newspapers.

He rushed to the phone at once to call up his boss.

"Hello," he shouted. "Did you see the announcement of my death in the newspapers?"

"Yes," the boss replied. "Where are you calling from?"

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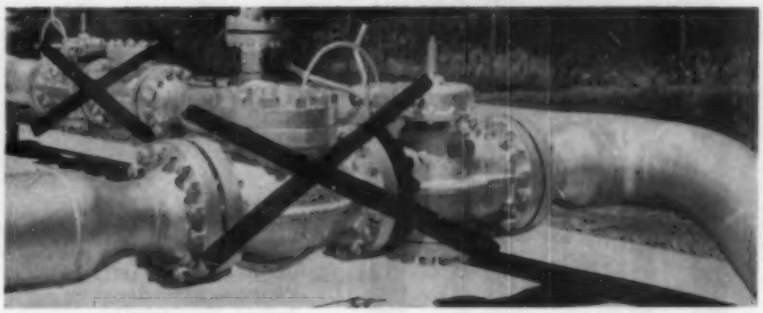

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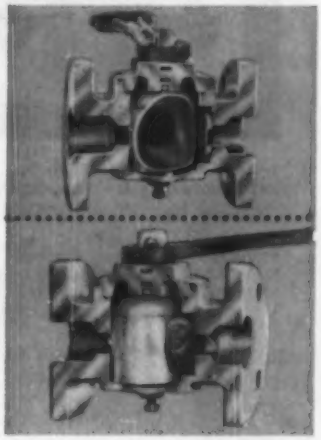

Cut-away illustrates PLUGAROO with plug "closed" (top) and as check valve "open" (bottom).

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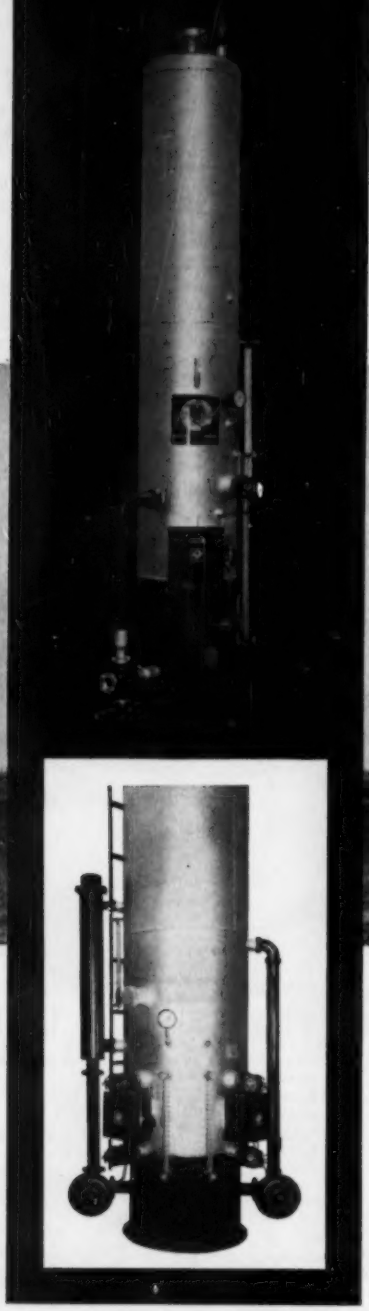
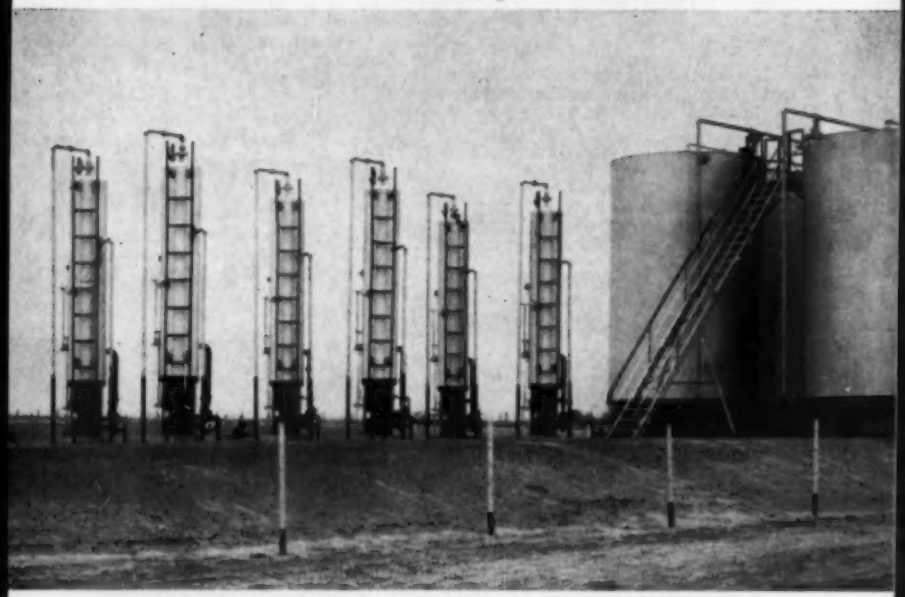


National Two-Phase Metering Separator separates and measures production from individual wells for commingling.

•

National Three-Phase Metering Separator for separating and measuring oil and water for individual well testing.



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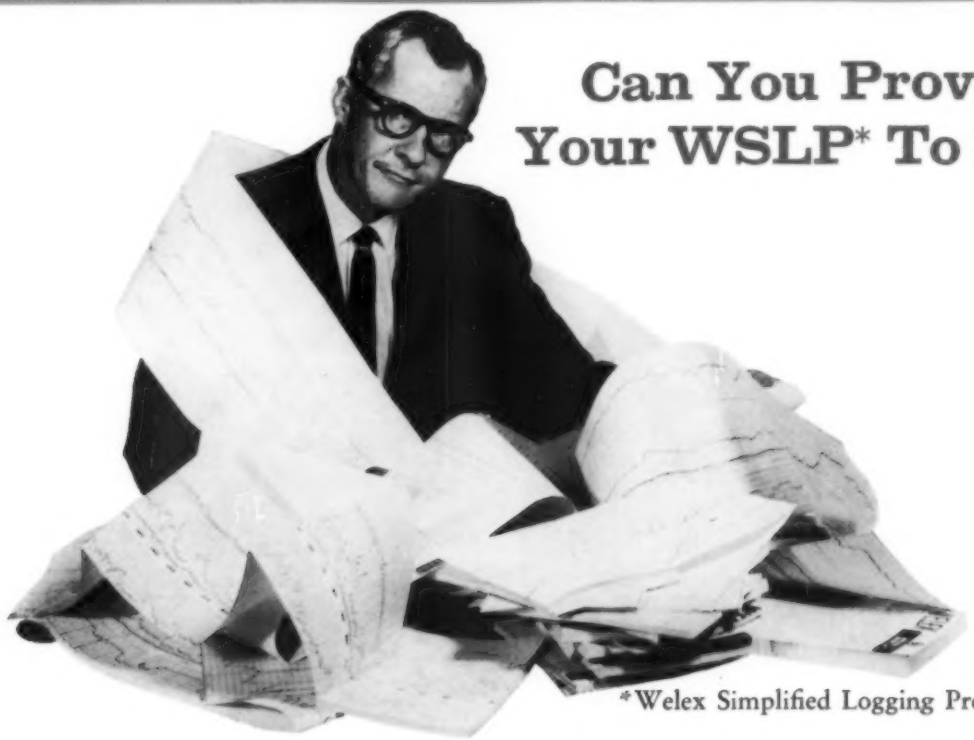

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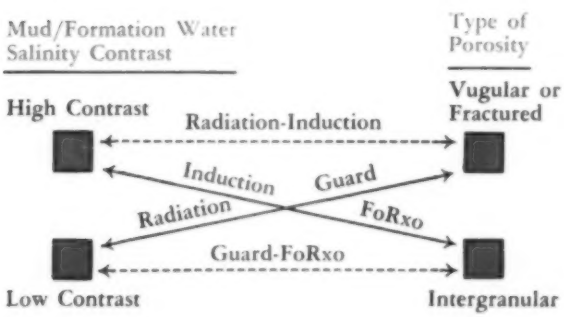

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MILE-A-DAY DRILLING IN THE GULF, recently achieved by Gulf Oil Corp., will lead to even higher drilling rates in this offshore area. New record was the culmination of several years' experience by Gulf in evaluating optimum rotary speeds, weight on bit, and circulation rates. Though all drilling practices in this area are not applicable everywhere, continued interest in record-breaking drilling rates here will be of universal benefit.

RADAR BEAMS MAY HELP UNLOCK VISCOUS OIL reserves through a new instrument being developed by Raytheon Company under an agreement with Petro-Electronics Corp. of Denver. Basically an electronic oil well heater, the unit employs special electronic generators of very high frequencies, in the microwave band. Microwaves emitted provide penetrating heat to surrounding formations to reduce viscosity. Engineers will package 5000 to 10,000 watts of power into a capsule 6 in. in diameter which will be field-tested later this summer in northwestern Montana. Units will also be used for downhole paraffin control.

NEW AIR MOTOR DRILL WILL FIND A PLACE in the attack on several old drilling problems. Delta Drilling Company has used the tool, manufactured by Ingersoll-Rand Company, in initial field tests with notable results. Using two vane-type motors in parallel to drive a bit sub at 400 rpm, the tool has shown increased penetration rates with reduced weight on the bit. This low-weight, high-rpm combination also reduces hole deviation problems and requires fewer drill collars for economic drilling rates.

FIRST CARBON DIOXIDE WATER FLOOD IN TEXAS has been planned for the White and Baker field, Pecos County, by Helmerich & Payne, Inc., American Petrofina Company of Texas, and Oil Recovery Corp. The three-stage project would be expected to recover about 6,000,000 bbl of secondary oil from 1200 acres of the 20 to 25-ft thick Queen Sand. Operators expect that 2,000,000 bbl of the total would be attributable purely to the CO_2 process with the rest recoverable by conventional waterflood techniques. In previous field tests, carbonated water injection rates have been obtained ranging from 130% to 890% of conventional water injection rates.

CONTINENTAL-EMSCO'S

prime movers for unit pumpers are better because

YOU HELPED DESIGN THEM

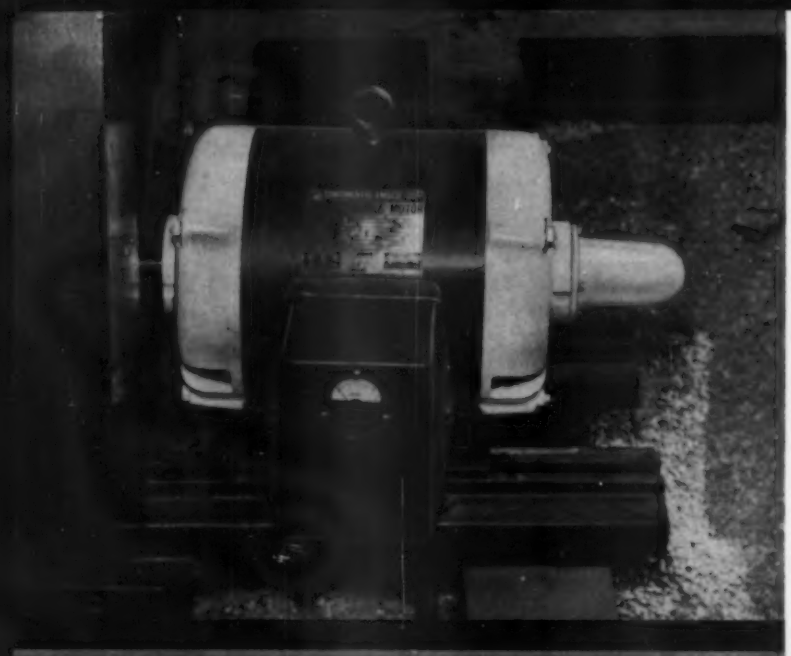
Without your help, C-E Pumping Engines and Green Triangle Electric Motors might have been just another line of prime movers, converted from other industries' applications. But field engineering reports from companies like yours revealed what you wanted . . helped engineer the one line of prime movers for oilfield pumping that fill all your needs for higher efficiency, lower maintenance costs and longer life . . *all at competitive prices.*

Out of your needs grew the C-E Pumping Engine . . the first medium-speed, single-cylinder model with a unitized clutch — replacing bulkier, more expensive engines. None today match its flywheel effect, simplicity of servicing and operation, and built-in load-limiting feature.

With increased electrification, Continental-Emsco developed the Green Triangle Electric Motor to match your needs for greater efficiency. It was designed to sell competitively, without reducing frame size and copper or increasing the heat rise. It won't run hot or fail prematurely, because it was engineered from the start for unit pumper service . . not adapted by juggling ready-made components.

There are other advantages, too — available only because C-E is a fully-integrated supply company: constant research, devoted exclusively to oilfield problems . . a maintained stock of some 1700 of these prime movers at C-E supply stores, strategically located throughout the oilfields of the U. S., Canada, and Venezuela, fully backed by auxiliary equipment, spare parts and service . . and best of all, *C-E's exclusive WARRANTED APPLICATION.* What other supplier offers so much?

If your responsibility is in management, engineering, or purchasing, you owe it to yourself to write for details — or hear the full story when your C-E man next calls. Get all the facts about the one line of prime movers that offers the most economy per dollar invested . . so that your company, too, can *pump more profits.*



DESIGN FEATURES YOU CAN RELY ON..

Green Triangle Electric Motors

BUILT-IN BALANCE METER.. cuts wear and tear on all well equipment by permitting accurate well counterbalancing. Lower Power Costs.. accurate counterbalancing assures maximum lifting efficiency at the lowest possible electrical cost. **SLIP OF 6-10%**.. starting torque of 275% with 1.15 *guaranteed* service factor, 50° C rise, 130° C insulation.. these features mean lower peak current demands and correspondingly lower power cost.

QUICK AND EASY INSTALLATION.. double-shaft extension, rotation in either direction, leads from either side, and diagonally-split, oversize conduit box give you application flexibility for economical field hook-ups. Hold-down bolts for any unit pumper can be used in motor's 21/32" bolt holes.

ALL-WEATHER DEPENDABLE POWER.. splashproof frame and uni-directional air cooling assure top performance regardless of weather conditions. Enclosure is splash proof by NEMA standards. **SIZE RANGE**.. from 3 to 100 horsepower.

"CONVERTIBLE" MOTORS.. minor modification changes motor from three phase to single phase or back again. Motor delivers name plate rating at 1200 rpm on single phase power. Original cost is generally less than 1200 or 1800 rpm single phase motors. Ready availability and increased salvage value are also assured.

C-E Engines

EASY TO START.. hot, cold or wet weather conditions do not make these engines temperamental. **EASY TO ADJUST**.. governor, valves and carburetor can be reached easily for quick field adjustment. **EASY TO SERVICE**.. no long shutdown here; water or oil can be added and their levels checked while engine is running. **EASY TO REPAIR**.. unit assemblies and essential working parts can be replaced in the field without disturbing other assemblies. **THREE MODELS**, ranging from 10 to 20 horsepower for continuous service. Proven by over 15 years of highly satisfactory performance in oil fields everywhere.. over 30,000 on producing wells.

CONTINENTAL-EMSCO

Serving the Oil and Gas Industries ... Worldwide

CONTINENTAL-EMSCO COMPANY
A Division of The Youngstown Sheet and Tube Company
General Offices: Dallas, Texas
Export Division: 30 Rockefeller Plaza, New York, N. Y.
Continental-Emsco Company Limited
General Offices: Calgary, Alberta, Canada
Continental-Emsco Company C. A., Caracas, Venezuela
Plants: Houston and Garland, Texas;
St. Albans, Herts, England
Representatives in All Principal Oil Fields of the World

PM 001

Invest $171

Investing $171 for a barrel of Duomeen® CD-50 is obviously less costly than shelling out $1700 for a load of new pipe. Yet every year oil producers are paying out millions of dollars to replace pipe that failed, due to the corrosive environments in water systems. By using Duomeen CD-50, a combination corrosion inhibitor and bactericide, much of this needless expense can be avoided.

Extensive field tests have established sulfate-reducing bacteria to be one of the more important factors in causing corrosion. Thorough investigations have also proven the effectiveness of Duomeen CD-50 in preventing the harmful effects of these bacteria.

Additional savings result with the use of Duomeen CD-50 because many costly remedial measures are eliminated. Savings are effected by the prevention of

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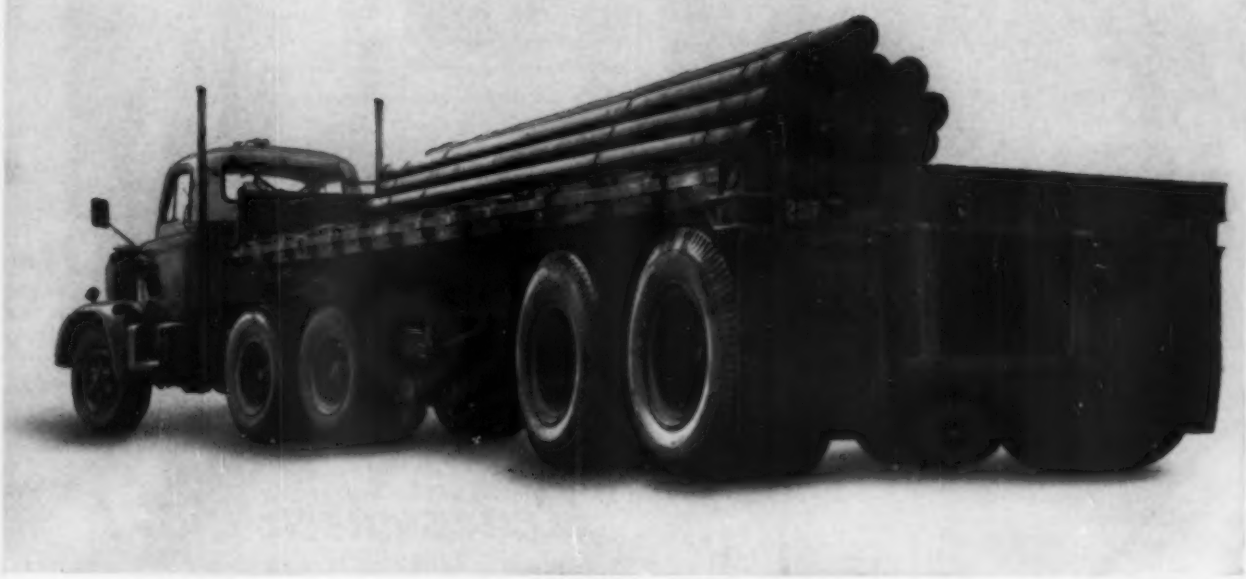
Save $1700



bacteria and bacterial by-product plugging, less down-time, and lower power costs to maintain injection pressures.

For complete detailed information on Armour's bactericides—corrosion inhibitors and other chemicals for oil production, write for the booklet, "Armour Organics for Increased Oil Production." Samples of Duomeen CD-50 and other Armour oil production chemicals for your own testing are also available.

Armour Industrial Chemical Company
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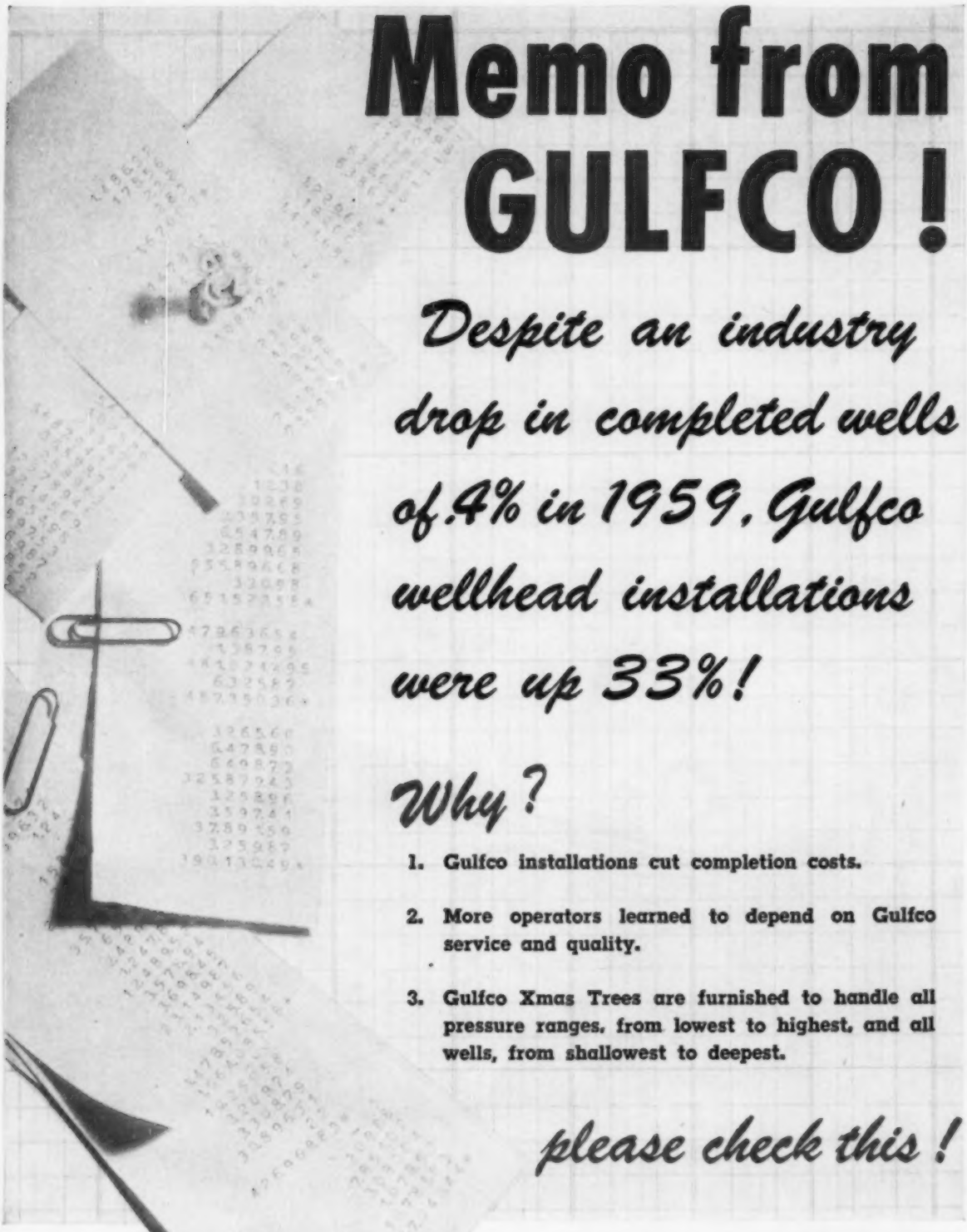
110 North Wacker Drive • Chicago 6, Illinois



Memo from GULFCO !

Despite an industry drop in completed wells of 4% in 1959, Gulfco wellhead installations were up 33%!

Why?

1. **Gulfco installations cut completion costs.**
2. **More operators learned to depend on Gulfco service and quality.**
3. **Gulfco Xmas Trees are furnished to handle all pressure ranges, from lowest to highest, and all wells, from shallowest to deepest.**

please check this !

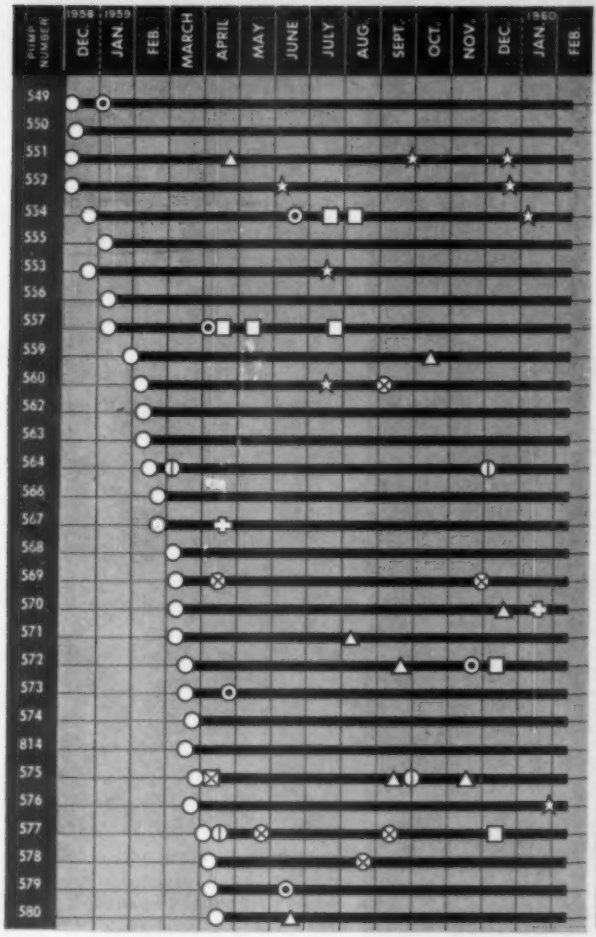
GULF COAST MACHINE & SUPPLY CO.

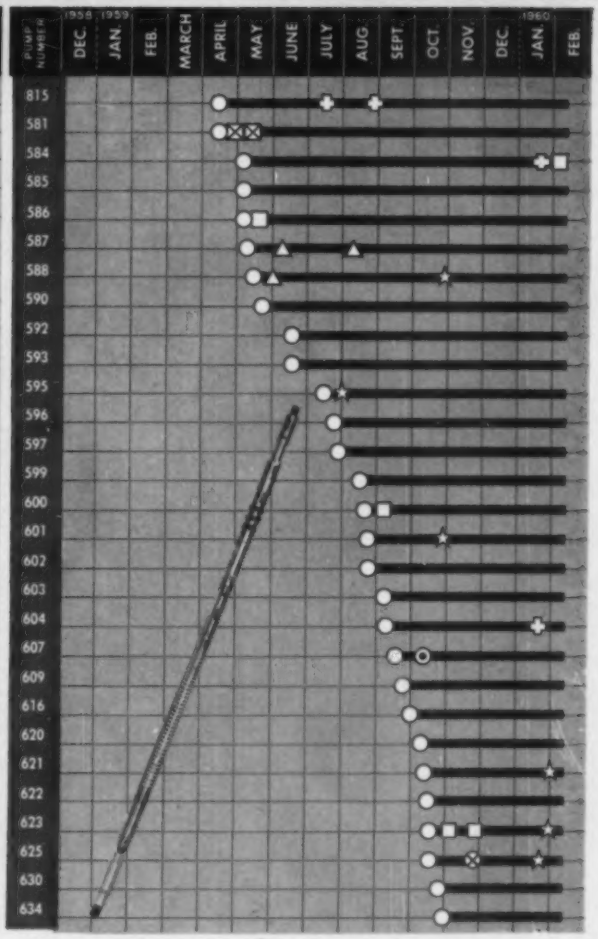
Beaumont, Texas

ASSOCIATION OF WELL HEAD EQUIPMENT MANUFACTURERS CERTIFIED

GULF COAST MACHINE & SUPPLY CO. GULFCO TRADE MARK PRODUCTS BEAUMONT, TEXAS

LOOK AT *Your Pump Records* TOO-





Above pump record represents 16,454 pump days of operation. 64 pulling jobs give an average of 257 pump days per pulling job. Detailed percentages below represent exact cause of pulling job.

- ○ PUMP INSTALLED
- ◉ BROKEN PART 10.9%
- □ TUBING LEAK CHECKED PUMP 18.8%
- ⊗ ROD FAILURE-CHECKED PUMP 10.9%
- △ BALL AND SEAT FAILURE 17.2%
- ◐ SANDED-UP 6.3%
- ☆ CORROSION FAILURE 21.9%
- ✪ RINGS CUT OUT 9.4%
- ⊠ FOREIGN MATERIAL IN WELL 4.6%

AVERAGE FIRST COST ON ABOVE NUTEX PUMPS $220.40

Above is one year actual day by day installation and repair of Nu-Tex pumps on several leases by one company. This record on wells 4500 to 8400 feet deep shows why they are continuing to change over to Nu-Tex. As the days go by the run average increases.

Increase production — cut cost at once!

Typical pump runs:
291 days
Repair cost $69.10 (Average for Above Pumps $43.86)
Running in low volume, hi-corrosion well at 6307 feet. Nu-Tex rings now pumping at 8428 feet. Pump No. 581 shown above.

BRADFORD MOTOR WORKS

BRADFORD MOTOR WORKS
General Office and Factory – Bradford, Pennsylvania
Branch Office and Factory — Tulsa, Oklahoma
Warehouse — Odessa, Texas
Excell Specialty Co. — Edmonton, Alberta, Can.

Here's the answer for a truly efficient, all-purpose bridge plug—one so simply constructed, with no moving parts, that it will not fail mechanically—so positive in sealing action that you get a leak-proof seal under hydrostatic pressures as high as 13,000 psi—yet so versatile it will successfully accomplish the most difficult plugging operations as well as the easiest.

The McCullough Bridge Plug is an explosive-expansion plug made of drillable aluminum. It is set at the desired location by the power of expanding gases from within the plug. On permanent installations it will last as long as the pipe in which it is set. It is ideal for temporary plugging operations as it drills out quickly and easily with a rotary bit.

TAKE A LOOK AT THESE FEATURES

- Simple, one-piece, all-aluminum construction. Slips, reins, rubber packers and all hardened or moving parts that might impede drilling out have been eliminated.
- No slips to hang up or accidentally trip and set the plug while going in the hole.
- Makes a positive leak-proof seal under the heaviest hydrostatic or mechanical loads.
- Easier on the pipe than a slip-type plug.
- Because it's shorter and smaller in diameter it easily passes through tight spots, dog legs, etc., and saves rig time in running, locating and setting.
- Drills out easier and faster.
- Resists corrosion and electrolysis.
- Available in 37 sizes from 1¾" OD to 10½" OD for tubing, drill pipe, casing and in open hole in hard formations.

How much CF&I Casing and Tubing *should go into this new well?*

Someone once asked Abraham Lincoln, "how long should a man's legs be"? The president replied, "long enough to reach the ground". The same is true of CF&I Seamless Casing and Tubing. You need enough to protect your investment and bring oil to the surface.

Why should you insist on CF&I Casing and Tubing? Because it is made from top grade steel . . . subjected to strict quality control throughout every stage of production . . . and meticulously manufactured in one of the most modern mills in the industry.

CF&I's Seamless Casing and Tubing mill is only hours away from the heart of the oil country. This assures rapid delivery — either directly from our Pueblo, Colorado mill or through our network of strategically located distributors.

All CF&I Casing and Tubing exceeds API Specifications. It's available in sizes 2⅜" to 9⅝" O.D. For complete information or technical service, contact a nearby CF&I sales office.

7910

CF&I STEEL **SEAMLESS** *casing and tubing* API

THE COLORADO FUEL AND IRON CORPORATION • DENVER, COLORADO

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Demand Careful Equipment Investment

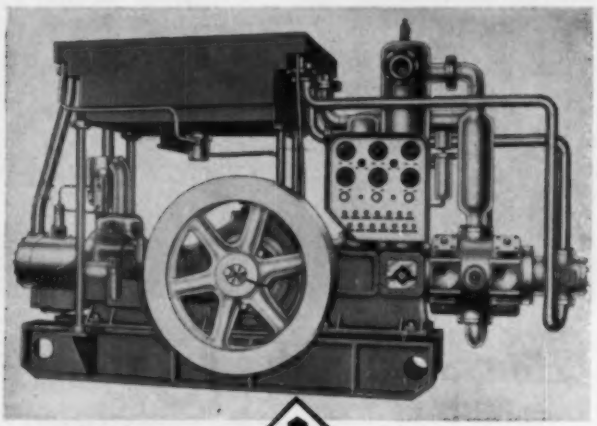
These three new Ajax Full Dollar Value Single Engine Compressor Units have been designed to help you buy closer to your actual needs with a reasonable margin of power reserve.

DPC-60 — 60-HP
DPC-80 — 80-HP
DPC-115 — 115-HP

Equipment investment costs are more critical today than ever before.

Let Ajax engineers work with you to determine your real needs and minimum investment for maximum returns from equipment and equipment investment.

Send for detailed technical specifications brochure today.



THE *NEW* DPC-60 ENGINE-COMPRESSOR UNIT

AJAX

AJAX COMPRESSORS

AJAX . . . also builders of ENGINES . . . PUMPS

AJAX IRON WORKS CORRY, PENNSYLVANIA
Oil Field Distributors

- The National Supply Co. — Pittsburgh, Pennsylvania
- Bethlehem Steel Co. — Supply Division, Tulsa, Oklahoma
- Mid-Continent Supply Co. — Fort Worth, Texas

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

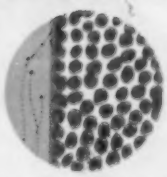
You save drilling dollars with a Baroid Mud Program

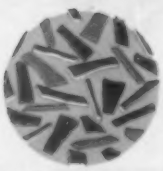
THE MUD PROBLEM AND ITS SOLUTION **DMS***

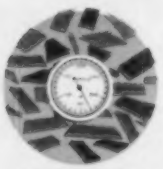
When the problem is to keep mud stable in the presence of extreme heat, salt contamination, hydratable shales and drilled solids build-up, the answer is DMS.

In this typical example, DMS was used as part of a complete mud program on a well in the Nicholson Field, Webb County, Texas. Total depth was 20,603 feet. The last 1400 feet was drilled with 3¾ inch bits. Bottom hole temperature of 456°F was recorded. Mud properties were easily controlled to prevent troubles in this small diameter hole and at these high temperatures.

Use DMS for a surfactant mud system that resists adverse conditions at great depths and high temperatures. DMS is one of Baroid's complete line of mud products that is available through a single, coordinated chain of service that *saves your drilling dollars.*


THIN FILTER CAKE


STABLE DEFLOCCULATED MUD


KEEPS MUD STABLE AT HIGH TEMPERATURE

LESS HOLE TROUBLE

BAROID

BAROID DIVISION NATIONAL LEAD COMPANY

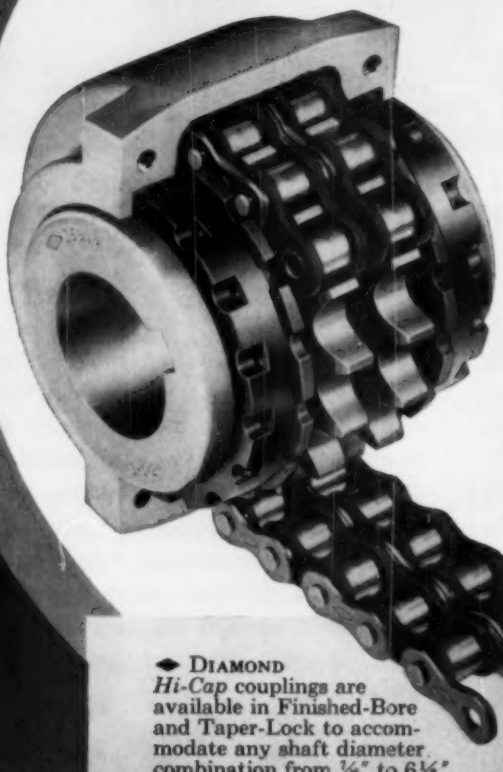
MAIN OFFICE: P. O. BOX 1675, HOUSTON 1, TEXAS

*Registered Trademark of Magnolia Petroleum Company

6045

NOW...select
flexible couplings by SHAFT SIZES

new
shaft-rated
DIAMOND *hi-Cap** TM



COUPLINGS
give you
- lower cost
- bearing and shaft protection
- quick, easy selection and installation

***Hi-Cap means HIGH CAPACITY**
All working parts are heat treated steel, and hardened to provide greater resistance to wear, longer service life.

DIAMOND *Hi-Cap* couplings are available in Finished-Bore and Taper-Lock to accommodate any shaft diameter combination from ⅛" to 6½". New *Hi-Cap* Bulletin No. 1060-C gives construction details, specifications and prices. WRITE TODAY!

DIAMOND CHAIN COMPANY, INC.
A Subsidiary of American Steel Foundries
Dept. 441 402 Kentucky Ave., Indianapolis 7, Indiana
Offices and Distributors in All Principal Cities

DIAMOND ROLLER CHAINS

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Diamond Chain Company, Inc.

*The trademark *Hi-Cap* is the property of Diamond Chain Company, Inc.

Trinity
LITE-WATE

A Complete Low Density Cement that is

HIGHLY IMPERMEABLE

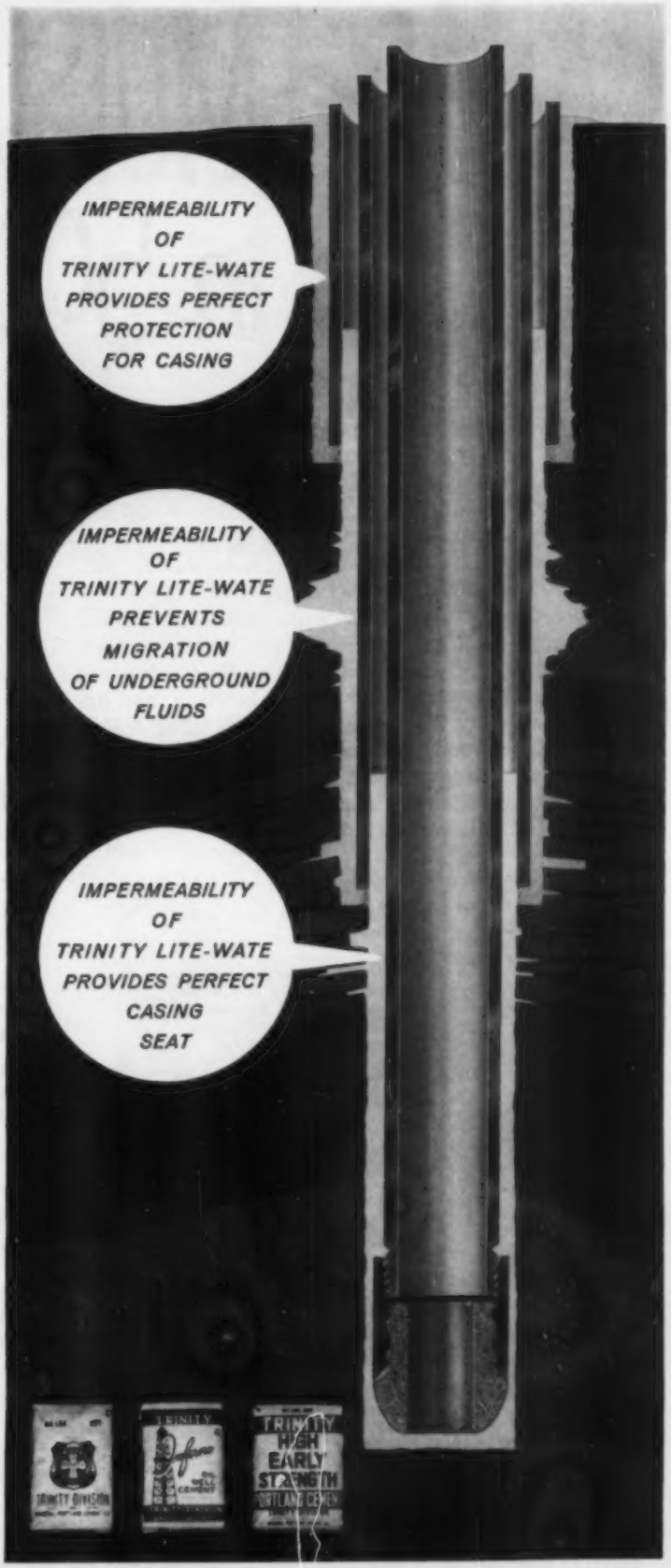
Trinity Lite-Wate fulfills all important functions when placed in an oil or gas well.

PERMEABILITY TEST DATA

All slurries were prepared according to procedures of API RP 10B and cured at 140°F and atmospheric pressure for 72 hours.

Percent Mixing Water	Slurry Wt. Pounds Per Gallon	Permeability Millidarcys*
65	13.66	0.001
75	13.18	0.001
85	12.77	0.001
95	12.44	0.001
105	12.14	0.002
115	11.89	0.003

*A darcy is that measurement of permeability that will permit a liquid having a viscosity of one centipoise to flow at the rate of one milliliter per second through a specimen one centimeter in length and having a cross section of one square centimeter under a pressure difference of one atmosphere. A millidarcy is 0.001 darcy. The permeability of Trinity Lite-Wate cement is expressed in millidarcys.


IMPERMEABILITY OF TRINITY LITE-WATE PROVIDES PERFECT PROTECTION FOR CASING
IMPERMEABILITY OF TRINITY LITE-WATE PREVENTS MIGRATION OF UNDERGROUND FLUIDS
IMPERMEABILITY OF TRINITY LITE-WATE PROVIDES PERFECT CASING SEAT
TRINITY
TRINITY HIGH EARLY STRENGTH

TRINITY

PORTLAND CEMENT DIVISION
GENERAL PORTLAND CEMENT COMPANY

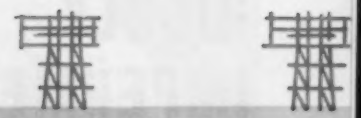
GPCC

DALLAS·FT.WORTH·HOUSTON

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

ATLAS EMULSIFIER saves $15,125 in 5000′ comparison

Carper Drilling Company of Artesia, New Mexico, is typical of contractors and operators that have been able to effect substantial savings in drilling costs by using an Atlas emulsifier. Here is a direct comparison of the drilling records of Carper's State MA-A #1, located in Lea County, New Mexico, Section 31, 17S, 33E, and an offset well in Eddy County, Section 29, 17S, 31E. Both wells were drilled about the same time through the same formation to a total depth of 10,000 feet. The rig used on the Carper well was smaller, having lower power, hoisting, and hydraulic capacity. The comparison well, using a low-solids CMC mud, required over twice as many bits at an additional cost of $7,425; difference in rig time accounted for another $7,700 . . . a total of $15,125 in tangible savings.



DRILLING RECORD COMPARISON

	STATE MA-A #1	OFFSET WELL
Mud	Atlosol emulsion	low-solids CMC
Interval	5,123′-10,015′	5,263′-10,011′
Feet Drilled	4,892	4,748
Rig Hours	857	997
Feet per hour	5.7	4.8
Bits	27	60
Feet per bit	181	79
Weight on Bit	30,000-45,000#	60,000-65,000#
Drill Pipe	3½″	4½″
Drill Collars	17—6″ x 2¼″	20—7″ x 2¾″
Pumps	1—18″ 1—14″	2—20″
Liner Size	5½″	6½″

Atlas emulsifier is sold through distributors under these tradenames . . . each is the product of Aquaness Department, Atlas Powder Company:

TRIMULSO®

Distributed by Baroid Division, National Lead Company

Registered trademark Baroid Division, National Lead Company

DRILLING MILK

Distributed by Magnet Cove Barium Corporation

Registered trademark Magnet Cove Barium Corporation

ATLOSOL

Distributed by Milwhite Mud Sales Company and other selected mud companies

Registered trademark Atlas Powder Company

Atlas Emulsifiers Improve a Good Drilling Fluid.

Better Hole Conditions. Torque is decreased as much as 50% . . . the hole is kept cleaner and pump pressures are correspondingly lower. There is less danger in loss-circulation and low-pressure zones.

Longer Bit Life. Prevents balling, provides better cutter and bearing lubrication. Greatly extended bit life reduces bit costs, reduces rig hours lost to trip time.

Faster Drilling Rates. More feet of hole per hour. Oil lubrication combines with improved hole condition to increase drilling rates in competent and troublesome formations.

ATLAS Aquaness CHEMICALS ATLAS POWDER COMPANY

Aquaness Department, Atlas Powder Company

P. O. Box 21072 • Houston 26, Texas

WHELAND HP-18000
DUPLEX POWER SLUSH PUMP
7¾"x18" 750 HP NOMINAL INPUT at 60 R.P.M.

WHAT IS THE *OPTIMUM* PUMP FOR YOUR JOB?

You consider the pressure and volume needed, the weight and cost of moving the pump, the cost of power to drive it and your initial investment.

More and more men who know how to use big pumps are coming to the studied practical conclusion that a 600 to 750 hp input pump is **OPTIMUM** for their operations.

The Wheland HP-18000 pump gives you up to 826 gpm and 1,322 psi with 7¾" liners and up to 388 gpm and 2,700 psi with 5½" liners. It weighs only 36,377 lbs., is easily moved in one piece, is rated at 750 hp at 60 rpm, has six big features combined on no other pump and a top record for performance and dependability.

Detailed bulletin sent on request.

It will pay you to see if this isn't the *OPTIMUM* pump for your job, too!

WHELAND
ROTARY DRILLING MACHINERY

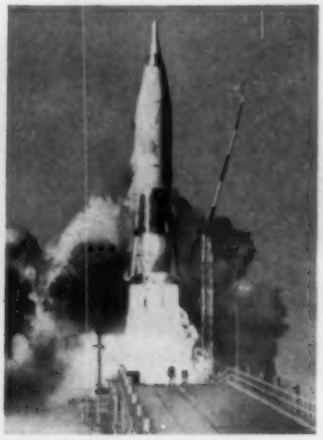
THE WHELAND COMPANY
CHATTANOOGA, TENNESSEE, U.S.A.

DRAW WORKS • SLUSH PUMPS • ROTARIES
CROWN BLOCKS • TRAVELING BLOCKS • SWIVELS

DOMESTIC DISTRIBUTORS: INDUSTRIAL SUPPLY COMPANY, INC.—Main Office: Wichita Falls, Texas • HOUSTON OIL FIELD MATERIAL COMPANY, INC.—Main Office: Houston, Texas.

EXPORT DISTRIBUTORS: LUCEY EXPORT CORPORATION—233 Broadway, New York 7, New York—Broad Street House, London, E. C. 2, England.

These Space age giants show you why
Rector casing heads give you positive protection



Rectorheads are *"Sealed With Steel"*

From deep below the polar ice cap to far into outer space the Nautilus submarine, the B-58 bomber and the Atlas Missile all face withering heat, arctic cold, crushing pressure and grinding torque.

The same welding principle that insures durability and safety in these jet age giants is utilized in Rector's "Sealed With Steel" casing heads to insure trouble-free completions for all types of oil and gas wells. Built to withstand heat, shock and highest wellhead pressure, Rector casing heads have a precision ground joint seat, fitted with a welding ring which is welded directly to the casing. An API ring gasket completes the exclusive ring of steel pioneered by Rector.

Rectorheads are available in sizes through 20" offered in service working pressures to 15,000 P.S.I. See your Rector representative or consult your favorite supply store.

30 YEARS MAKING THE OIL INDUSTRY SAFER

Rector

Well Equipment Co., Inc.

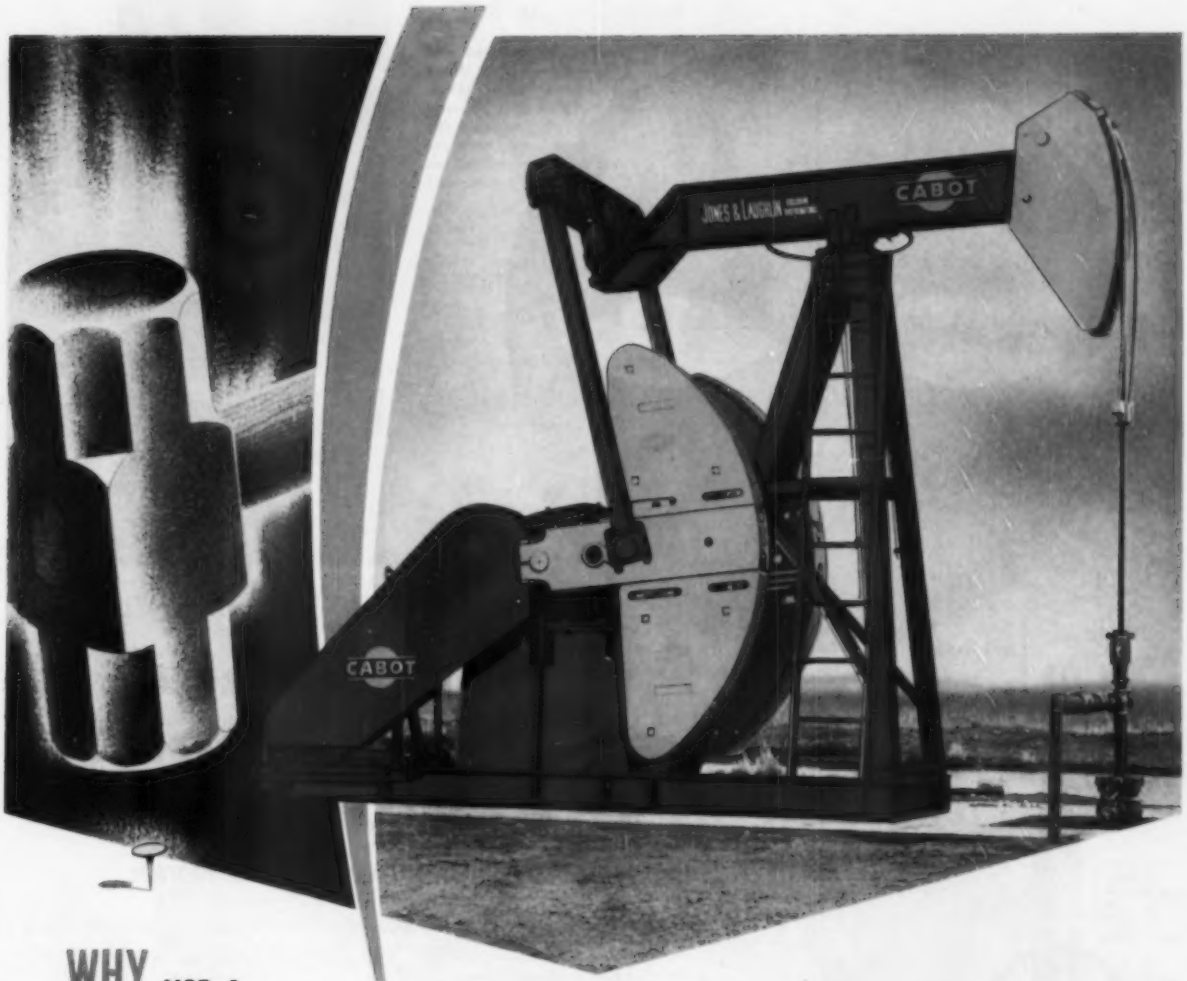
Making the Oil Industry Safer!

PESA

MONOGRAMMED EQUIPMENT CERTIFICATE NO. 2150

1100 North Commerce, Fort Worth, Texas Houston Plant: 2215 Commerce Street

EXPORT REPRESENTATIVES: Continental-Emsco Co., Mid-Continent Supply Co., Oilwell Division of United States Steel Corporation



WHY USE A SLEDGE HAMMER TO DRIVE A TACK?

CABOT SAYS: SELECT THE EXACT SIZE UNIT FOR YOUR PUMPING NEEDS

Why spend more for a pumping unit than you need to? In today's oil economy this becomes an important sobering question. That's why Cabot aims at holding your pumping costs down . . . That's why Cabot builds reserve ruggedness in every unit and then backs these units with 24-hour field service.

More and more producers have come to realize that the "Cabot Habit" is the sensible answer to economy and operating demands.

CALL YOUR J&L MAN...

OIL FIELD PUMPING EQUIPMENT
CABOT
PAMPA, TEXAS
FRANKS DIVISION OF CABOT

There's good material and plenty of it in these packing elements. (Note the big holes—big because the packer bores are big and unrestricted.)

TWO BASIC MODELS

Model J (Product 756-J) is long-string set. Model K (Product 756-K) is short-string set. Both come with or without hold-down buttons (double or single grip). The picture shows double-grip Model J.

How to make a dual-string hookup that works

Required: a dual packer that works

NOTHING DEFEATS THE ECONOMICS of a dual completion like a dual packer that leaks. You must have a positive and dependable packoff.

It's fundamental—to make a dual string hookup work, you must have a dual packer that works, one that packs off and holds. That, many operators state plainly, is the reason they are using the new Baker duals.

WHAT MAKES THE PACKOFF SO POSITIVE? The reasons are designed into the simple and rugged 3-element packoff mechanism you see in the pictures.

There's been a lot of favorable comment on this design. It holds so well it doesn't need the non-retractable metallic back-up rings that so often stick to the casing and defeat retrievability. The 3-element concept came out of a tough proving ground. It was adapted from Baker's high-performance retrievable squeeze packers, proved in thousands of high pressure downhole operations.

BUT WHEN YOU'RE MAKING THE HOOKUP, you discover that while a positive packoff is essential, it isn't everything. You must have flexibility, too.

When you want to space out, to test packers before displacement—that's when you discover the importance of a packer that offers repeat setting.

A BAKER SNAP-SET DUAL is one packer that gives you both pressure holding power and flexibility. You set and pack off by setting down minimum weight—and the packer holds. You release by picking up.

It's just that simple. You don't pressure, you don't rotate, you don't drop balls—and you don't come out of the hole to re-cock.

You set and unset as many times as you need to. And when your hookup is made, you've got one that works.

BAKER SNAP-SET DUAL PACKERS

BAKER OIL TOOLS, INC.

HOUSTON LOS ANGELES NEW YORK

49 PAGES OF FACTS

With big pictures and few words, a new brochure tells the interesting engineering facts about Baker's new Snap-Set Dual Packers. Get it from Baker representatives, or write to Baker Oil Tools, Inc., P.O. Box 2274, Terminal Annex, Los Angeles 54, California.

The story behind . . .

GULF'S MILE-A-DAY DRILLING RECORD

Combination of rotary speeds up to 250 rpm, bit weights of 60,000 lb, and 640 gpm of mud at 3000 psi drills 5412 ft in 24 hr

RAY GROSS
Area Drilling Engineer
Gulf Oil Corporation, Morgan City, Louisiana

RECENTLY a Gulf Oil Corporation-Dixie Drilling Company team drilled 5412 ft of 9⅞-in. hole during a 24-hr period. The well is located in Timbalier Bay field in Louisiana and was drilled with Dixie Drilling Company's Rig No. 3.

This record could not have been achieved without the excellent cooperation between Gulf and Dixie Drilling Company. Morale of the rig personnel was very good and excellent teamwork of a well-trained and inspired crew produced more than a mile of hole in a 24-hr period.

Dixie Rig No. 3 has two 1640-hp mud pumps and an independently powered pump for mud mixing. Driving the two mud pumps are three turbo-charged diesels, each rated

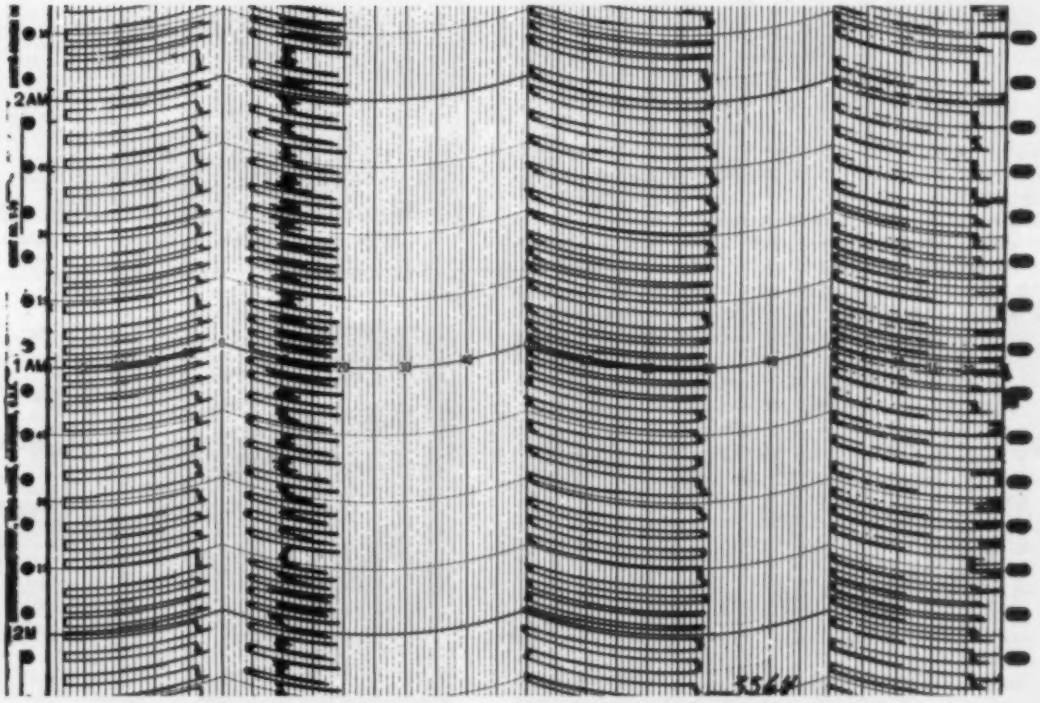


FIG. 1. Record penetration rate is reflected in the drilling chart which shows 400 ft per hr average drilling past 3500 ft hole depth. Chart shows 84 strokes per min pump speed, 80,000 lb weight on bit, 3000 psi pump pressure, and 250 rpm rotary speed. Finding right combination of these factors gave fastest drilling.

Angeles 54, California.

your hookup is made, you've got one that works.

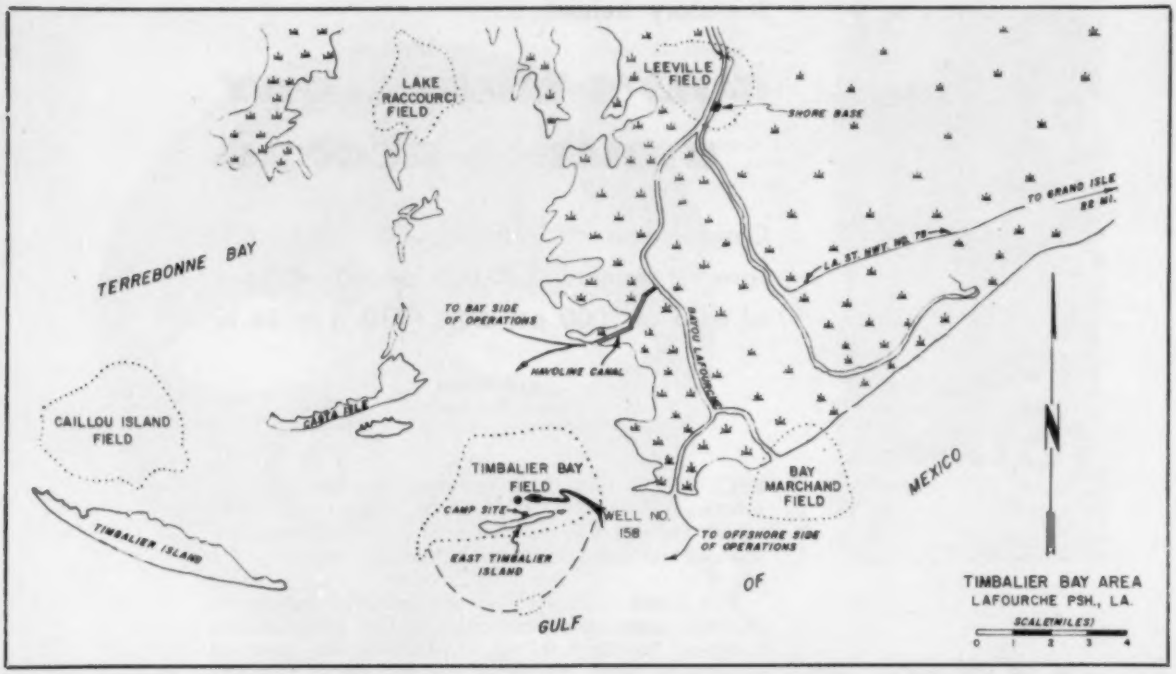


FIG. 2. **Timbalier Bay field** is site of Gulf's Well No. 158. Dixie Drilling Company's large inland barge Rig No. 3 was used to drill the record-holding well in relatively shallow water off East Timbalier Island.

at 1100 hp. The engines are mechanically compounded to drive rotary, drawworks, and pumps.

Before Dixie Rig No. 3 arrived on location, a 20-in. drive pipe was driven to the point of refusal. After the rig was moved on location, Gulf's special wellhead was installed on the 20-in. drive pipe with two 12-in. ram-type blowout preventers and a 12-in. annular preventer: Blowout preventers were then tested to the maximum working pressure before spudding.

Crews lost no time in drilling 2043 ft of 15-in. hole in four hours. The 15-in. hole was drilled with a 12¼-in. long tooth rock bit followed up by a 15-in. underreamer.

All three turbo-charged diesels, totaling 3300 hp, were mechanically compounded driving rotary, drawworks, and pumps. Two 1640-hp pumps were run in parallel, stroking 84 spm with 6½-in. liners. This gave a total output of 1300 gal per min. With three ¾-in. jets, jet velocity was 310 ft per sec. Annular velocity was 156 ft per min. Indicated surface pressure was 2500 psi.

Running all three engines together gave the maximum horsepower available for pumping, rotary speed, and hoisting speed, which helped speed up connections.

Drilling fluid consisted of bay water and weight of the mud returns weighed 9.5 to 10.5 lb per gal. Viscosity was 28 to 32 sec per quart.

After surface hole was drilled, pipe was pulled out of the hole and 2022 ft of 10¾-in. casing was run and cemented. Total time from spud until casing was cemented was ten hours.

Twelve hours were consumed waiting on cement, nippling up, testing blowout preventers, picking up a bottom-hole assembly, and going in the hole to drill.

Bottom-hole assembly consisted of a 9⅞-in. long-tooth shale bit with three 13/32-in. jets. A lubricator sub was placed immediately above the bit. Orifice sizes in the lubri-

FIG. 3. **High capacity power drilling barge** Rig No. 3 is equipped with heavy-duty drawworks and one of the most powerful mud systems ever assembled, driven by three mechanically-compounded turbo-diesel engines.

FIG. 4. **Heavy-duty drawworks** rapidly hoisted and lowered drill string during record drive, allowing crew to connect sections in 1.5 min. Fast drilling practices resulted in drilling down a section in 30 to 40 sec.

cator sub were calculated so that they would distribute a special high-pressure lubricant to the cones throughout the expected life of the bit. Eighteen 7½-in. OD drill collars were placed on the 4½-in. OD drill string composed of 16.6-lb grade E internal upset pipe with 6⅛-in. OD flash-weld tool joints.

Record Push Under Surface Casing

The driller quickly drilled through plastic-cored wiper plugs and float shoe staying constantly busy making hole with no lost time in back reaming or circulating. Drilling progressed rapidly making 3969 ft of 9⅞-in. hole before a pressure relief valve on a pump gave way and an hour was lost making repairs. Crewmen resumed drilling and progressed 5114 ft during this 17-hr run, including down-time.

Drilling rate indicated bit wear and the crew spent the next four hours pulling the drill string out of the hole, removing the worn bit, and attaching another of the same type. Then they cut and slipped 80 ft of drill line and went back in the hole.

Hour by hour drilling log provides an interesting look at the record-breaking mile-a-day drilling project:

First Day	
600 to 800	*Jetted out barge to move.*
800 to 1000	*Moved rig to new location.*
1000 to 1200	*Spotted rig on location and sank barge.*
1200 to 2100	*Installed well head on 20-in. drive pipe and nippled up three 12-in. 900 series blowout preventers.*
2100 to 2200	*Picked up 15-in. underreamer and a 12¼- in. long-tooth rock bit.*
2200 to 200	*Drilled to 2043 ft.*
200 to 300	*Pulled out of hole.*
300 to 400	*Closed 15-in. underreamer and pulled through blowout preventers.*
400 to 600	*Ran 2022 ft 10¾-in. casing.*
Second Day	
600 to 800	*Circulated and cemented casing.*
800 to 2000	*Nippled up blowout preventers, tested, went in hole to drill, and waited on cement.*
2000 to 600	*Drilled to 6078 ft.*
Third Day	
600 to 700	*Repaired pressure relief valve on pump.*
700 to 1300	*Drilled to 7157 ft.*
1300 to 1700	*Pulled out of hole, changed bits, slipped and cut 80 ft of drill line, and went in hole.*
1700 to 2100	*Drilled.*
2100 to 2200	*Changed gaskets in swivel goose neck.*
2200 to 2300	*Drilled to 7899 ft.*
2300 to 0400	*Pulled out of hole, changed bits, picked up three additional 7½-in. OD drill collars (making a total of 21 7½-in. OD drill collars), went in hole to drill.*
400 to 700	*Drilled to 8267 ft.*

ABOUT THE AUTHOR

Ray H. Gross, area drilling engineer for two years at the Gulf Oil Corporation offshore office in Morgan City, Louisiana, supervised drilling the record-breaking well. He graduated from Jacksonville State College in Alabama with a BS degree in chemistry. Then he entered Gulf's engineer training program in 1953 as a roustabout, roughneck, and pumper. After attending the Gulf mud school, he was assigned as mud engineer, drilling engineer, and offshore toolpusher and has five years experience in offshore operations.

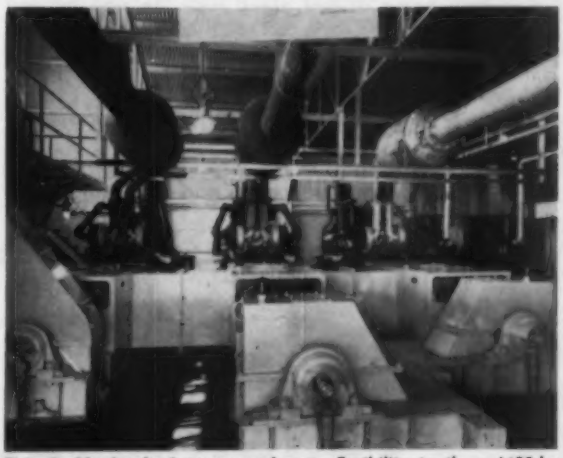


FIG. 5. **Mechanical compound** gave flexibility to three 1100-hp turbo-diesel engines which operated drawworks and mud pumps through torque converters and chain drives.

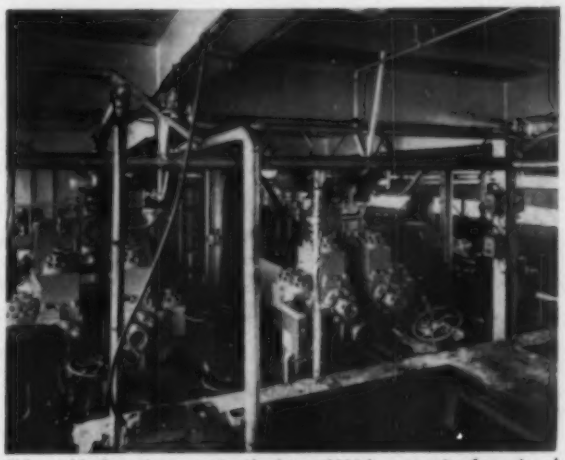


FIG. 6. **Mud system** consisted of two 2000-hp capacity forged-end mud pumps with an independently-powered mud mixing pump. Bay water forced at high pressure mixed with formation cuttings to make lightweight mud.

FIG. 7. **One of three** Dixie Drilling Company crews which drilled record well using Rig 3 are (left to right) Murphy Stute, toolpusher; W. L. Kirkpatrick; R. E. Harris; H. W. Merkel, driller; M. P. Thomas; E. Amos III.

FIG. 8. **Another of crews** which drilled record well is (left to right) Johnny Hester; Ira Cochran; J. E. Rawls, driller; Nolan Gaspard; John Galjoir; Euris Plaisance.

Crewmen began drilling ahead with the new bit and gained 298 ft of hole for a record 24-hr run of 5412 ft to a depth of 7455 ft.

Drilling Practices in 9⅞-in. Hole

Bit weight averaged 60,000 lb and rotary speed was 200 to 250 rpm.

Drilling fluid consisted of bay water. Bay water pumped at high pressure and high volume tears up "gumbo" and the loosely consolidated massive sands and shales, making mud weighing 9.5 to 10.5 lb per gal. Weight of the drilling fluid was dependent upon the rate of penetration. This contrasts with the usual use of high viscosity gel mud to float out the cuttings drilled. Viscosity of the drilling fluid ranged from 28 to 32 sec per quart. No circulation time, other than that required to drill a joint down, was required to maintain a clean hole. No gel or clay was added to the mud.

Hydraulics. One 1640-hp pump pushed 640 gal per min

Background notes on

The scientific and methodical study of drilling variables has increased tremendously in the past few years and has resulted in such impressive drilling feats as the present Gulf Oil Corporation record. Following is a review of this theoretical and field research leading to a prediction of completely automated drilling. The Editors.

IN 1955, Elmer Decker suggested that a subcommittee of the AAODC Rotary Drilling Committee be formed to study the effects of bit weight and rotary speed on rate of penetration. At the outset the program of the committee was set up to make a study of drilling reports and records in a given area. Due to somewhat sketchy reports and poor records available from the area under study, this project was abandoned in favor of actual field tests.

Field Tests

Field tests were initiated in West Texas in drilling an interval of some 2000 ft below the red beds. Weight on the bit, rotary speed, pump speed (spm)and drillstem torque were recorded on strip charts. In these tests, it was possible to obtain only about

FIG. 9. **Wilton R. Richard,** assistant drilling superintendent for Dixie, discusses pump that operated at 1640 hp forcing mud at 3300 psi during record run with **R. R. "Mickey" Simpson,** Gulf drilling foreman. Pumps were equipped with 6½-in. liners and had a stroke of 16 in.

FIG. 10. **Murphy Stute,** a Dixie toolpusher on Rig No. 3, discusses maintenance of powerful 1100-hp turbo-diesel engine with **Jack Courtney,** Dixie service engineer. Fast drilling requires keeping equipment operating at peak performance.

with an average of 3000 psi indicated surface pressure. Jet velocity with three 13/32-in. jets was 520 ft per sec. Annular velocity was 205 ft per min. At the end of the second 9⅞-in. bit run, surface pressure was 3500 psi.

Back pressure valve. A back pressure valve was used above the bit to prevent the drill pipe from flowing over during connections. This was an aid to crews in speeding up connection time. Connection time averaged 1¼ to 2 min per connection.

Through several years of experience in Timbalier Bay and many offshore fields, Gulf personnel have found what they believe to be the best combination of drilling fluid, hydraulics, rotary speeds, and bit weights for fast drilling.

Gulf personnel spent a great deal of time studying techniques used on bay and offshore rigs during drilling. The best techniques were kept and used again; the unsuccessful were discarded.

speed, weight, and penetration

three points on the curves where, with weight constant, the rotary speed varied. Where the rotary speed was constant, it was possible to obtain data from 10,000 lb on the bit up to the point where the bit foundered.

Rotary speed was limited by the fact that the rotary table was driven through drawworks from the compound and was limited to three speeds available from the drawworks transmission. Any increase in speed (rpm) over the highest speed available through the drawworks transmission had to be obtained by increasing the engine speed to the compound. This in turn would increase the pump speed which would inject an error in the data thus obtained.

Similar field tests were conducted in the Spearman area of the Texas Panhandle and in the West DeQuincy field of Louisiana. In spite of the few data points available in all of these test runs, it was possible to derive an equation which indicated rate of penetration to be an expotential function of rotary speed. Taking successive pairs of test runs at various rotational rates, it was possible to develop the equation, $P = K \times N^m$, where P is penetration rate in ft per hr; K is a constant; N is rotary speed in rpm; and M is an unknown power to be determined. In determining "M," it was assumed that penetration rate varied linearly with weight and the penetration rate was corrected to a standard of 30,000 lb on the bit.

In setting the observed data in the equation, the value of "M" in all cases was found to be less than one. In the softer drilling of the West DeQuincy field of Louisiana, "M" was found to have a value of 0.7 to 0.8. In the harder drilling of West Texas, the value of "M" was 0.43.

The value of "M" determined from the field tests indicates that, with constant weight on the bit, optimum rotary speed is the point at which further increases in rotary speed do not give appreciable increases in rate of penetration. As the value of "M" approaches 1.0, this figure becomes extremely high and the optimum value of "M" is governed by bearing life of the bit as well as tooth wear (see Fig. A). As "M" decreases, the optimum point of rotary speed, with respect to rate of penetration, is quite low. In hard rock drilling areas, optimum rotary speed is somewhere between 80 and 100 rpm.

Where rotary speed is held constant and weight on the bit varied the above equation becomes $P = K \times W^m$. In all

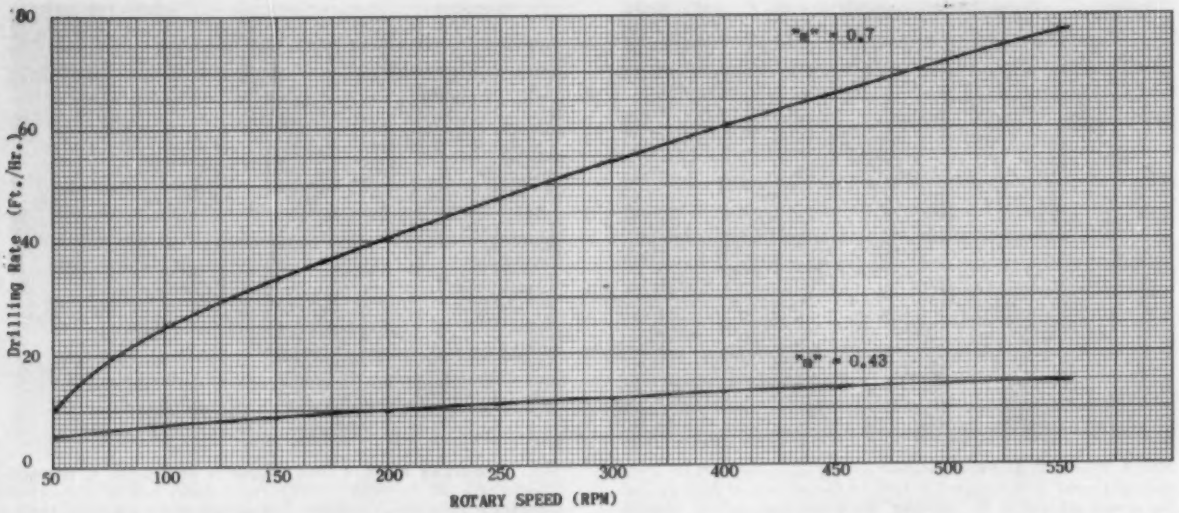


FIG. A. **Drilling rate vs rotary speed** (assuming weight on bit to be constant) follows the general equation, $P = Kx\ N^m$, where P is rate of penetration, K is a constant, N is rotary speed, and m is an exponent which varies with formation type. The value of m determined from field tests is approximately 0.7 for soft formations of Louisiana and around 0.43 for hard formations of West Texas.

field tests, "M" was approximately equal to 1.0 (see Fig. B). In one or two cases where insert bits were used in chert or extremely hard formations, the value for "M" was slightly greater than 1.0. These figures hold true in the range where a rock bit normally performs.

Drilling Economics

Economics of rotary speed and weight on the bit are continually being reviewed by the research departments of bit manufacturing companies with respect to design and performance of the bit. Bit manufacturers are attempting to evaluate field data so that by using a narrow rpm range and weight range with respect to a given set of hydraulic conditions, the number of feet that a bit will drill in a given formation can be estimated. Ed Galle of Hughes Tool Company, in discussing this subject before the Southwestern District of the API meeting in March of this year, noted that data in their possession revealed that an increase in speed from 50 rpm to 200 rpm, or a five-fold increase, will give approximately a ten-fold increase in the rate at which the cutting structure of the bit wears down. Similarly, a three-fold increase in the weight on the bit will cause a five-fold increase in the wear rate of the cutting structure.

Also, G. R. King, in a paper given before the 19th annual meeting of the AAODC pointed out that bearing life of a bit is inversely proportional to rotary speed and inversely proportional to the one and one-half power of weight on the bit.

It is apparent that engineers who are designing bits used by the drilling industry feel that there is a definite limit on the amount of hole that a given bit will cut in a given formation. Whether the bit will cut the maximum amount of hole or not depends on weight on the bit and rotary speed, assuming the best hydraulic conditions are used. Just what is the "best" set of hydraulic conditions for a given well in a given locality opens the door on an apparently never-ending argument.

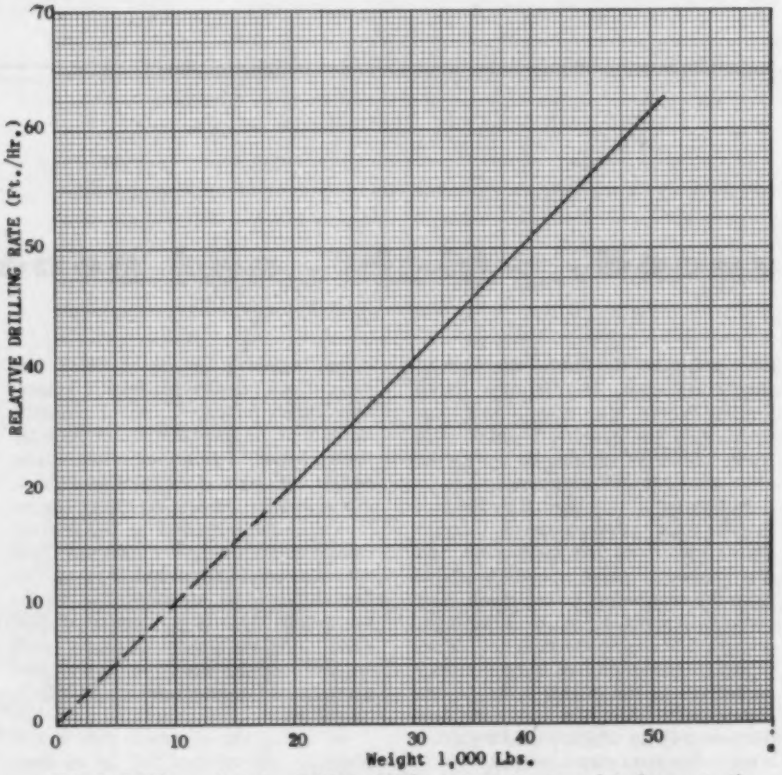


FIG. B. **Drilling rate vs weight on bit** (assuming rotary speed to be constant) shows these two functions to be directly proportional in most formations. The relation follows the general equation, $P = KxW^m$, where P is rate of penetration, K is a constant, W is weight on the bit, and m is an exponent which field tests show to be approximately equal to 1.0, varying slightly with bit type in some formations.

Drilling engineers are beginning to ask out loud, why does a bit get more footage faster when air or gas is used rather than water, and why does water give longer bit life and higher rates of penetration than mud, even when it has relatively low viscosity and low total solids or weight in lb per gal. A number of hypotheses have been advanced regarding the variables in the rate of penetration with respect to the physical characteristics of drilling fluids, but to date there has not been sufficient work done on this problem to give an adequate answer or series of answers.

Automated Drilling

In a somewhat extemporaneous talk before a joint meeting of Denver chapters of the AAODC, API and AIME, Bryant "Pete" Trenary of General Electric suggested the use of an automatic driller based on the principles of an electronic computer. As Trenary visualizes this computer, it will be set up on an equation based on weight and rotary speed with respect to the rate of penetration. Once the rig is set to drilling, the rotary speed and weight will be fed into the computer. The computer will then solve the simultaneous equation and feed back to the weight control the proper weight and to the rotary table the proper rotary speed to achieve the maximum rate of penetration with respect to the condition of the bit.

Trenary's idea is not as far fetched as it might appear at first glance. Bit manufacturers are seeking now to lower the cost of drilling by studies of the maximum economic life of their bits with respect to rotary speed and weight on the bit. Data from each well drilled is laboriously gathered, plotted, and analyzed. In areas where these analyses have been applied, costs have been lowered by ten to twenty percent. A computer which could handle these analyses in a few seconds would save hundreds of man-hours of work. It has been estimated that the cost of the computer suggested by Trenary would be in the neighborhood of $60,000, or about the cost of a mud pump.

As the rate of penetration is a function of rotary speed and weight on the bit (which is in turn a function of bearing condition and dullness of the bit), it is apparent that these studies are time consuming. As an example, Bill Koch and C. W. Haddon of Reed Roller Bit Company, using data from tests run by the AAODC committee, divided into five parts the penetration rates of three bits used in one formation. These five parts represented the first 20%, second 20%, third 20%, fourth 20% and fifth 20% of the life of the bit. Rate of penetration for each division was plotted against the product of weight and actual rotary speed. It can be noted that the rate of penetration drops by 20 to 25% from a new bit's rate to the point where 80% of the bit's effective cutting power has been utilized (Fig. C).

These curves may support the conjecture that it might be more economical to pull a bit that is not completely worn out but not making an economical rate of penetration. However, there are not sufficient data available at the moment that will allow the development of any criteria for pulling other than a completely worn bit.

Summary

Considerable progress is being made in the study of bit life and rate of penetration with respect to weight on the bit and rotary speed. It is apparent that to complete this picture, the functions of hydraulics of both air and mud as well as the "drillability" of formations must be studied. No doubt that when the picture of these functions is brought into sharp focus, it will be a triangular chart with one ordinate the weight/speed factor, another ordinate a hydraulic factor, and the third the drillability factor of the formation being drilled. ★ ★ ★

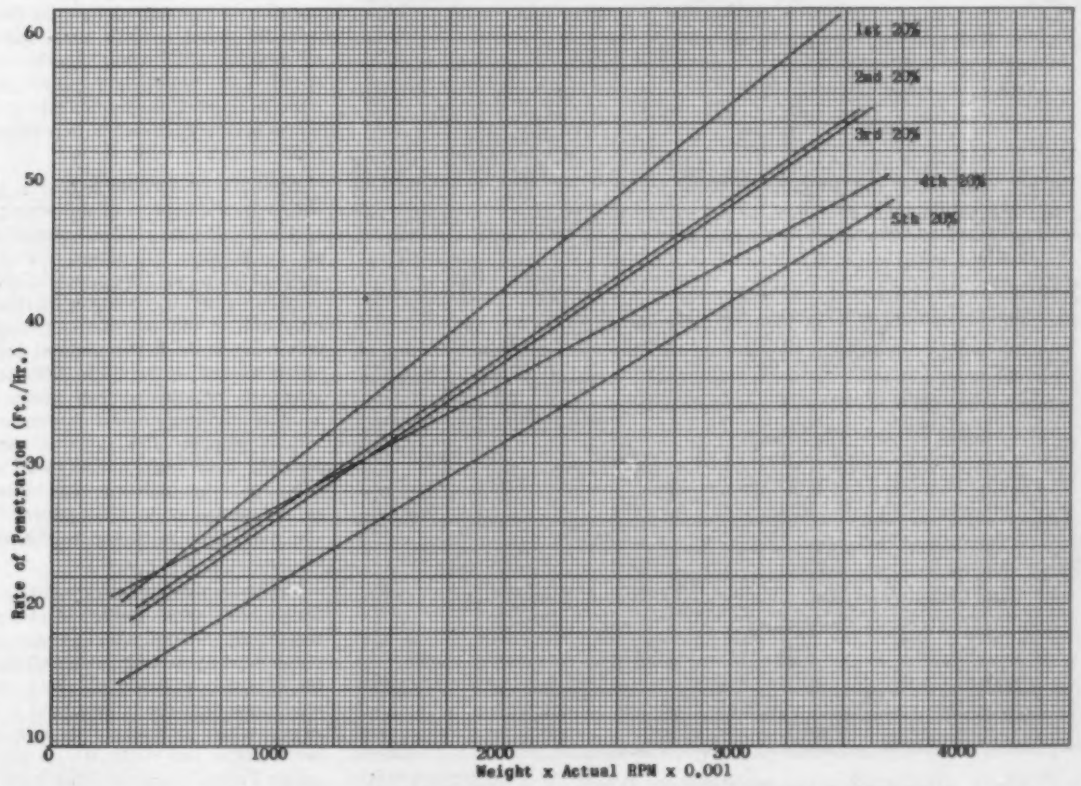


FIG. C. **Drilling rate vs the product of weight and rotary speed shows the effect of a worn bit on rate of penetration. Generally, penetration rate is reduced approximately 25% by a bit which is 80% worn.**

Dual centrifugal pump hookup

MUD MIXING IDEA SAVES

J. E. KASTROP, *The Petroleum Engineer*

Penrod Drilling Company uses this high-volume, low-pressure system for fluid-handling jobs on nine of its company rigs

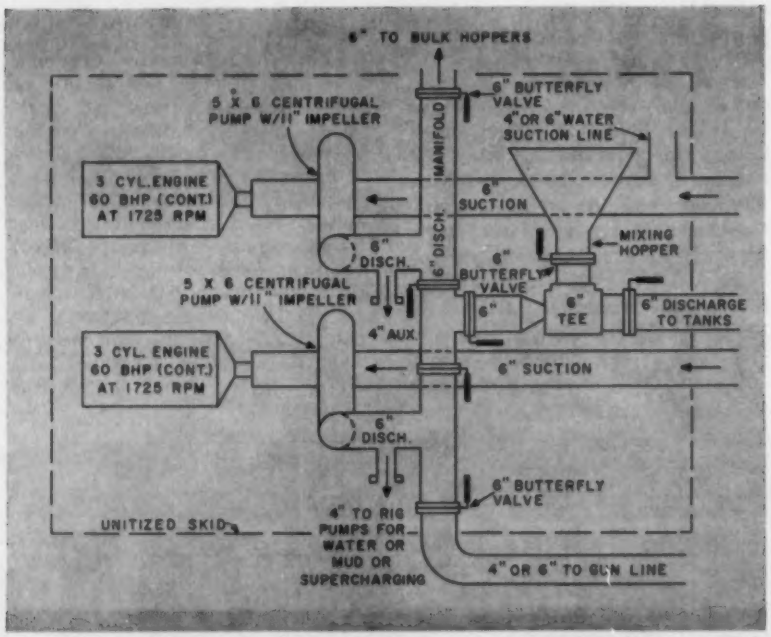
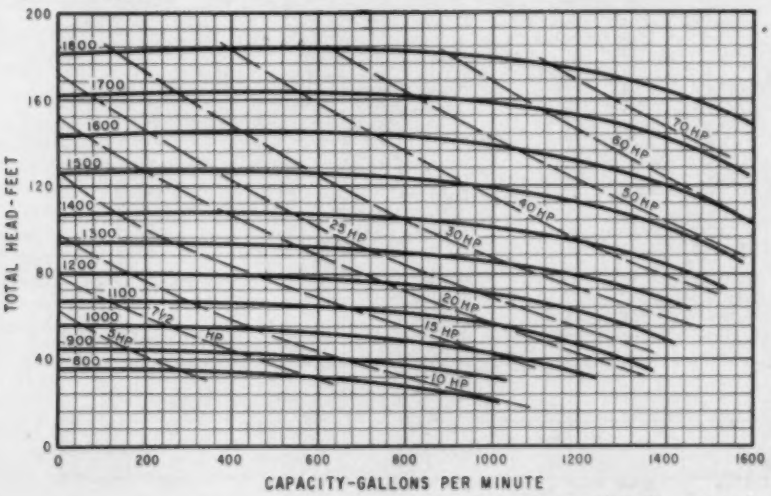

6" TO BULK HOPPERS
5 X 6 CENTRIFUGAL PUMP W/11" IMPELLER
6" BUTTERFLY VALVE
4" OR 6" WATER SUCTION LINE
MANIFOLD
3 CYL. ENGINE 60 BHP (CONT.) AT 1725 RPM
6" SUCTION
6" DISCH.
6" DISCH.
MIXING HOPPER
6" BUTTERFLY VALVE
5 X 6 CENTRIFUGAL PUMP W/11" IMPELLER
6"
6" TEE
6" DISCHARGE TO TANKS
4" AUX.
3 CYL. ENGINE 60 BHP (CONT.) AT 1725 RPM
6" SUCTION
6" DISCH.
6" BUTTERFLY VALVE
UNITIZED SKID
4" TO RIG PUMPS FOR WATER OR MUD OR SUPERCHARGING
4" OR 6" TO GUN LINE

FIG. 1. **Piping design** for Penrod's centrifugal pump mud mixing hookup which is separately skid-mounted and independently driven. This system has proved its flexibility for a number of fluid-handling jobs.



—*Courtesy Mission Manufacturing Co.*

FIG. 2. **Performance curves** for 5 by 6-in. centrifugal pump with a 12-in. diam impeller. Brake horsepower is motor size with service factor of 1.0 when pumping water with specific gravity of 1.0.

FAST MUD MIXING in relatively large volumes, casing and hole fillup, and mud tank stirring are some of the chores efficiently handled by a dual, independently-driven centrifugal pump hookup worked out by Jack Johnson, manager and W. L. "Bill" McDonald, Jr., assistant drilling superintendent, Penrod Drilling Company of Dallas, Texas.

In the past 2½ years, nine company rigs were equipped with these low-pressure, high-volume units at a saving over conventional mud mixing hookups of some $20,000 per installation. Each unit is simple in design, lighter in weight, easy to rig up, tear down, transport, and operates independently of the rig drive or rig pumps.

Heart of the system is two 5 by 6-in. centrifugal pumps (Fig. 1) with 11-in. impellers separately driven by two 3-cylinder diesel engines, each rated at 60 bhp at 1725 rpm. At this rated speed and horsepower, each pump handles about 1200 gal per min at over 40 psi discharge pressure, depending on mud weight.

Special consideration had to be given the hydraulic aspects of the piping system and design of the manual mud mixing hopper. The design now in use evolved from past experience, trials and improvements. It is possible by running only one of the centrifugal pumps to mix mud through the manual hopper about as fast as the crew can cut the sacks. By paralleling both pumps into a single discharge manifold connect to a bulk hopper, 750 sacks of weight material have been mixed in 25 minutes. And, this high rate was no strain on the pumps, so it is not known what the maximum mixing capacity might be.

Limits on mixing lost circulation materials have been established to a relative degree. No difficulty has been experienced when mixing 30 to 40 lb per bbl of lost circulation materials, but it was found that the pumps tend to lose prime when attempting to mix such materials in the 90 to 100 lb per bbl range. Penrod designers believe the system will handle up to 50 lb per bbl of lost circulation materials.

$20,000 PER RIG

How This Idea Differs

It has become almost standard practice to employ a separate slush (reciprocating) pump for the sole purpose of mixing and transferring mud at the rig. If the rig was not big enough to justify a third pump (two for drilling and one for mud mixing) the standby or second mud pump was used for this purpose. On larger rigs, where it is normal practice to use two big pumps for drilling, a third and smaller slush pump is employed primarily to mix, transfer and jet drilling mud.

Perhaps one of the earliest field-fabricated pieces of drilling equipment was the jet-type manual mud mixer and hopper. Dry mud and/or additives were dumped into the hopper which feeds into a high-velocity jet stream where the mixing occurs. These conventional mud mixing hoppers were equipped with ⅜-in. or ½-in. jet nozzles. Several hundred pounds of pressure was required to attain proper mixing while mud volumes pumped through the jet may be only 200 to 600 gal per min. And, it took from 150 to 300 hp to drive these relatively high-pressure, low volume pumps. Fuel costs on these larger mud mixing units ran as high as $45 per day and maintenance costs up to $15 per day. Centrifugal units operate at fuel costs averaging $15 per day and maintenance as low as 25 cents per day.

Characteristics of centrifugal pumps are the key to the difference between the two systems. When these characteristics are better understood, only a few adjustments in design and operating procedure are needed to make this system function effectively.

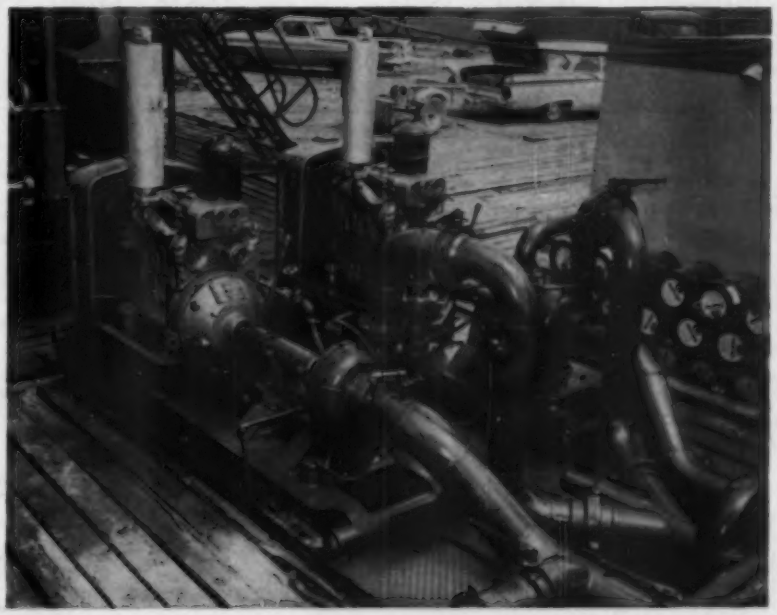
Centrifugal pumps are quite effective where large volumes are handled at relatively low pressures. This is of fundamental importance in orienting and evaluation and approach to centrifugal pumps for mud mixing. Fig. 2 is a performance curve for a 5 by 6-in. centrifugal pump with a 12-in. impeller when pumping water. It has been Penrod's experience that high-volume, low-pressure mud mixing can be done with these units when properly installed.

What To Consider

When working with larger volumes and lower pump discharge pressures, more attention must be paid to the hydraulics of the system. For example, the jet nozzle on the manual mud mixing hopper must be enlarged to 1½ or 2-in. to reduce the back pressure at this point and to permit the flow of larger volumes. An ideal mud mixing hopper design for use with centrifugal pumps is shown in Fig. 3.

It is important to design the entire mud system for minimum friction loss to gain the maximum benefits from this type unit. In some cases, line sizes should be increased to minimize friction losses and to permit high volume flow necessary for proper mixing. The suction line to the centrifugal pump must be as short as possible and at least one pipe diameter larger than the pump suction to insure adequate flow into the pump. Although some of the earlier installations of this type required the hopper to be mounted above the mud level so the discharge could empty directly into the tank, by proper sizing of lines, the hopper now can be located conveniently at ground level. Discharge from both pumps is through a 6-in. line up over the top edge of the mud tank.

Earlier problems. Penrod's initial installation on Rig 6 used a concentric reducer at the pump suction. When first operated, it was not possible to pump out the air bubble that had formed in the top of the reducer . . . even though the entire hopper and pump unit was below mud tank level and the pump had been filled with water. A small air vent was installed



Early centrifugal pump hookup for mud mixing unit on Penrod's big land Rig 14. While basic design was retained, changes were made in recent installations to streamline both suction and discharge piping.

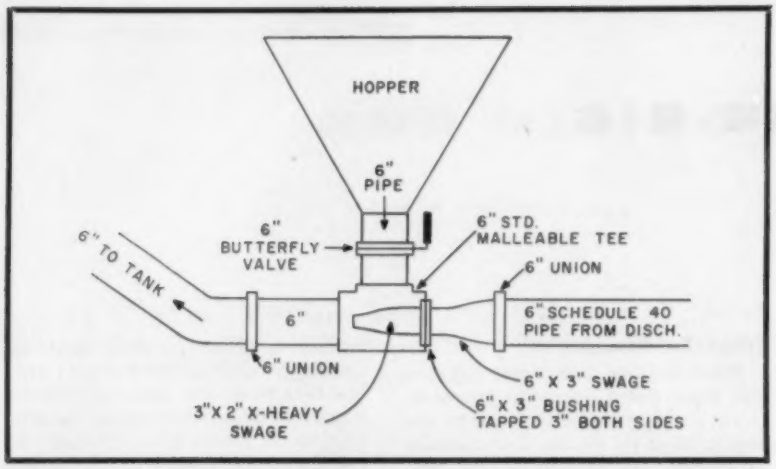


FIG. 3. **Proved hopper design** for high-volume mud mixing when using low-pressure centrifugal pumps. Made from standard pipe fittings, this hopper can handle a wide range of fluid densities, and will not plug up when mixing lime and gel.

in this reducer at the high point in the suction line. A standard gate valve in this line permitted the air to be bled off, and no further difficulty was experienced. Recent designs solve this problem completely by installing an eccentric reducer on the suction so the belled side of the reducer is on bottom.

How Unit Is Hooked Up

Penrod's newest design, shown in Fig. 1, has proved most satisfactory for overall operation. This plan was arrived at after several designs were considered, installed and tried. While it is possible to get by with smaller size pipe in some parts, this particular design has permitted top performance with little maintenance.

Suctions to both centrifugal pumps are 6-in. and as short as possible. Each pump discharges through a 6-in. line to a 6-in. manifold equipped with three butterfly valves for flexibility of use.

From this manifold, mud can be pumped through a 6-in. line to the modified manual hopper (Fig. 3), which discharges through a 6-in. riser over the top edge of the mud mixing tank. By running the line in this manner, the number of connections (for land rigs) is minimized to expedite rig ups and tear downs.

One end of the discharge manifold flanges into either a 4 or 6-in. line resting on top edge of the mud tanks (Fig. 4) to supply mud to guns for stirring the tanks. The other end of the manifold discharges through a 6-in. line to the bulk hoppers. Four-inch lines tee off this 6-in. discharge from each pump, and connect to cementing units, rig pumps for water or mud, for supercharging rig pumps or for casing and hole fillup. The unit also has been used for jetting mud and cuttings from the tanks. Although it would readily jet out the fluid, it would not satisfactorily jet sand and cuttings which had set-

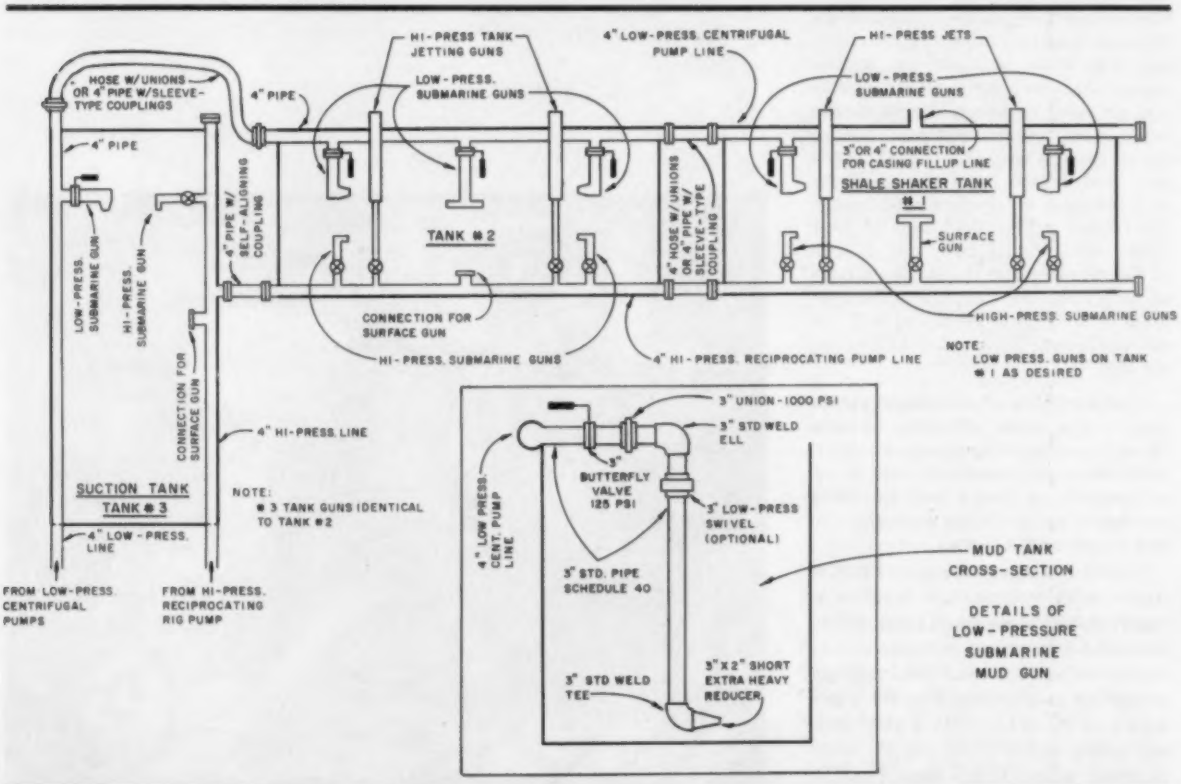

HI-PRESS TANK JETTING GUNS
4" LOW-PRESS. CENTRIFUGAL PUMP LINE
HI-PRESS JETS
HOSE W/UNIONS OR 4" PIPE W/SLEEVE-TYPE COUPLINGS
4" PIPE
LOW-PRESS. SUBMARINE GUNS
LOW-PRESS. SUBMARINE GUNS
4" PIPE
3" OR 4" CONNECTION FOR CASING FILLUP LINE
SHALE SHAKER TANK #1
LOW-PRESS. SUBMARINE GUN
HI-PRESS. SUBMARINE GUN
4" PIPE W/ SELF-ALIGNING COUPLING
TANK #2
4" HOSE W/UNIONS OR 4" PIPE W/ SLEEVE-TYPE COUPLING
SURFACE GUN
CONNECTION FOR SURFACE GUN
HIGH-PRESS. SUBMARINE GUNS
HI-PRESS. SUBMARINE GUNS
4" HI-PRESS. RECIPROCATING PUMP LINE
NOTE: LOW PRESS. GUNS ON TANK #1 AS DESIRED
CONNECTION FOR SURFACE GUN
4" HI-PRESS. LINE
3" UNION - 1000 PSI
3" STD WELD ELL
3" BUTTERFLY VALVE 125 PSI
4" LOW PRESS CENT. PUMP LINE
3" LOW-PRESS SWIVEL (OPTIONAL)
MUD TANK CROSS-SECTION
SUCTION TANK TANK #3
NOTE: #3 TANK GUNS IDENTICAL TO TANK #2
4" LOW-PRESS. LINE
3" STD. PIPE SCHEDULE 40
DETAILS OF LOW-PRESSURE SUBMARINE MUD GUN
3" STD WELD TEE
3"X2" SHORT EXTRA HEAVY REDUCER
FROM LOW-PRESS. CENTRIFUGAL PUMPS
FROM HI-PRESS. RECIPROCATING RIG PUMP

FIG. 4. **Proposed piping arrangement** for tank stirring when three tanks are used. This is a dual system for use of either/or both low-pressure and high-pressure mud systems. Inset shows design details of low-pressure submarine mud gun for stirring mud.

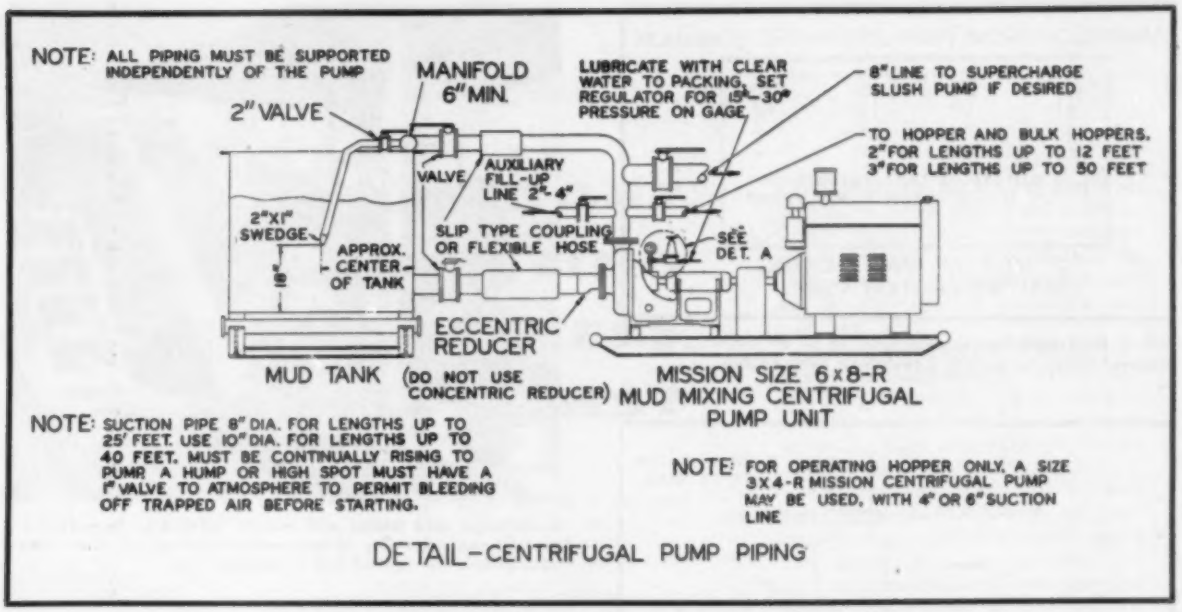

NOTE: ALL PIPING MUST BE SUPPORTED INDEPENDENTLY OF THE PUMP
MANIFOLD 6" MIN.
2" VALVE
LUBRICATE WITH CLEAR WATER TO PACKING, SET REGULATOR FOR 15#–30# PRESSURE ON GAGE
8" LINE TO SUPERCHARGE SLUSH PUMP IF DESIRED
TO HOPPER AND BULK HOPPERS. 2" FOR LENGTHS UP TO 12 FEET 3" FOR LENGTHS UP TO 50 FEET
VALVE
AUXILIARY FILL-UP LINE 2"-4"
2"X1" SWEDGE
APPROX. CENTER OF TANK
SLIP TYPE COUPLING OR FLEXIBLE HOSE
SEE DET. A
ECCENTRIC REDUCER
MUD TANK
(DO NOT USE CONCENTRIC REDUCER)
MISSION SIZE 6x8-R MUD MIXING CENTRIFUGAL PUMP UNIT
NOTE: SUCTION PIPE 8" DIA. FOR LENGTHS UP TO 25' FEET. USE 10" DIA. FOR LENGTHS UP TO 40 FEET. MUST BE CONTINUALLY RISING TO PUMP. A HUMP OR HIGH SPOT MUST HAVE A 1" VALVE TO ATMOSPHERE TO PERMIT BLEEDING OFF TRAPPED AIR BEFORE STARTING.
NOTE: FOR OPERATING HOPPER ONLY, A SIZE 3X4-R MISSION CENTRIFUGAL PUMP MAY BE USED, WITH 4" OR 6" SUCTION LINE
DETAIL–CENTRIFUGAL PUMP PIPING

FIG. 5. **Suggested single pump hookup** using larger centrifugal pump (6 by 8-in.). This design points out a number of features which require special attention in fabrication to affect good hydraulics and satisfactory results.

tled to bottom. On this basis, the unit is not being used nor hooked up for tank jetting.

Modified Mud Mixing Hopper Design

In order to get more energy through the manual mud mixing hopper, it was necessary to modify former designs. The new design is shown in Fig. 3. Since the pressure differential across the jet was much lower than conventional higher-pressure pumps created, the nozzle of the new hopper was enlarged to 2-in. as shown to minimize back pressure and permit the flow of greater fluid volumes. By so doing, the energy available for mud mixing was increased.

The hopper connects to the pump discharge manifold with a 6-in. line. This line is reduced to 3-in. with a 6 by 3-in. swage. Body of the mixing jet assembly is a standard 6-in. malleable tee. The 6 by 3-in. swage screws into a 6 by 3-in. bushing that has been tapped front and back for 3-in. standard pipe threads.

The jet nozzle is actually a standard 3 by 2-in. extra heavy short nipple that screws into this bushing. End of the jet nozzle extends just beyond the bend in the 6-in. tee. The cone-shaped hopper is mounted on top and connected to the 6-in. tee by 6-in. nipples and a 6-in. butterfly valve.

While smaller size pipe and fittings would suffice (4-in. for example), the 6-in. sizes provided greater areas around the nozzle. When mixing gel and lime, this area tends to become plugged unless sufficient area is provided. Penrod follows the practice of washing out this nozzle area at the end of each mud mixing operation. Proof of the non-plugging feature of this enlarged area around the jet nozzle was demonstrated by filling the hopper full of gel and lime during mixing to see if it would plug up. No plugging was experienced.

Some Proposed Hookups

One way to hookup a single centrifugal pump for handling these chores is shown in Fig. 5. This design indicates a 6 by 8-in. centrifugal pump. Note that pipe laterals indicated on the 6 or 8-in. discharge line provide for: (1) circulating mud back into the mixing tank through swedged (2 by 1-in.) nipples for mud stirring; (2) filling up casing or hole through a 2 or 4-in. line; (3) mixing mud where the fluid is discharged to the mixing hopper through a 2 or 3-in. line; and (4) supercharging the suction or rig pumps through an 8-in. line.

Butterfly valves are recommended for quick and full opening under lower pressures. Such valves rated for 125 psi seal quite satisfactorily.

Main discharge lines should avoid sharp bends and constrictions. Lines to the mud mixing hopper should be at least 2-in. in diameter, (preferably 3-in.) and swedged to 2-in. at the hopper.

For tank agitation, a 6 or 8-in. discharge line should be used to feed a 6-in. mud gun line running the length of the tank as shown in Fig. 6 and equipped with four 2-in. gun lines. All lines should be as short as possible . . . particularly the suction lines . . . which should also be free of leaks to prevent air entrainment.

New suction manifold design, or a possible alternate to that shown in Fig. 1, is presented in schemmatic form in Fig. 7. This design requires relocating the dual pumps and drives, but improves the hydraulics of suction flow by the 10-in. manifold and also adds to the flexibility of the dual hookup.

Pump Packing Needs Proper Lubrication

Special consideration of the centrifugal pump packing is required when handling fluids with high abrasive content. While rod packing in reciprocating pumps can be lubricated by dropping oil on the shaft where it is carried into the stuffing box, packing on a centrifugal pump must be lubricated under enough pressure to force the lubricant under all packing rings because the rotating motion of the shaft does not carry oil into the stuffing box, but wipes the packing dry.

In addition, centrifugal pumps operate at shaft surface speeds over three times the surface speeds of reciprocating pumps. For this reason, the shaft is plated with hard, abrasion-resistant chromium beneath the packing. And, the packing itself, contains as much lubricant as possible. However, the external source of oil, grease or water

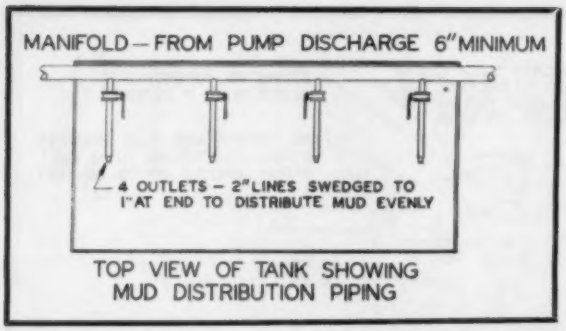

MANIFOLD — FROM PUMP DISCHARGE 6" MINIMUM
4 OUTLETS — 2" LINES SWEDGED TO 1" AT END TO DISTRIBUTE MUD EVENLY
TOP VIEW OF TANK SHOWING MUD DISTRIBUTION PIPING

FIG. 6. **Mud agitation** in each tank can be accomplished by this proposed design for use with a centrifugal pump hookup.

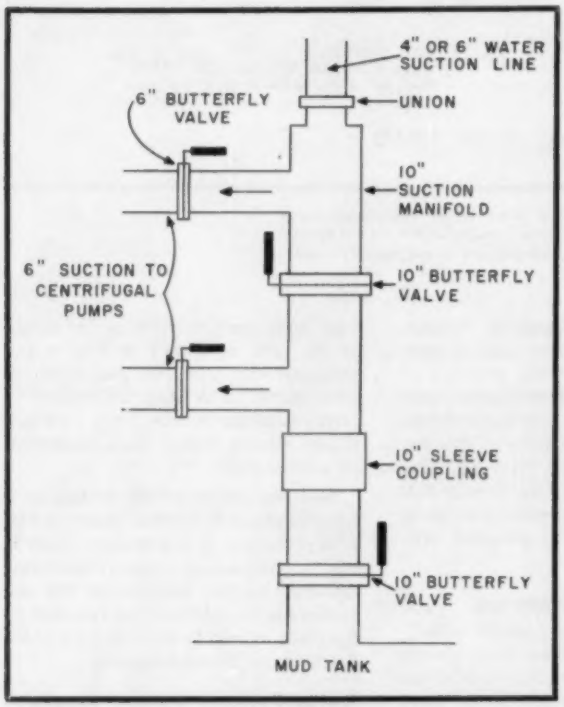
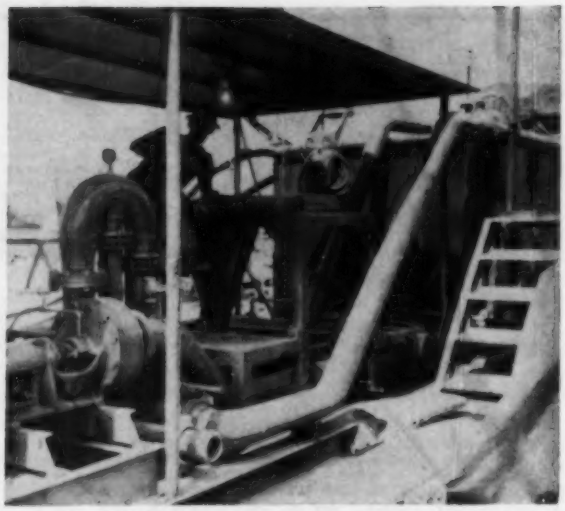
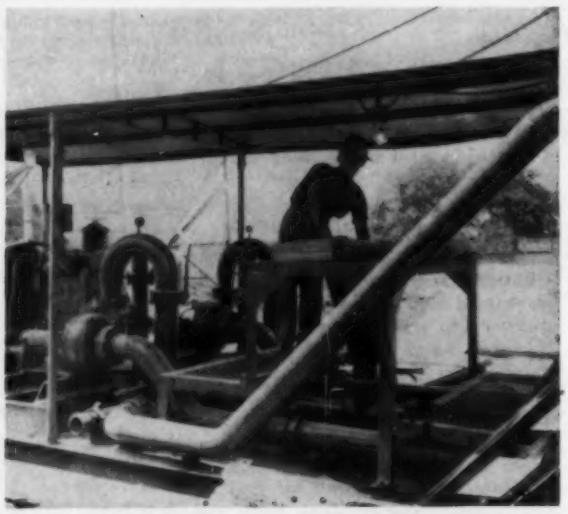


FIG. 7. **Alternate suction piping design** requires relocating the dual centrifugal pumps, but does improve the hydraulics and flexibility of the system.



Centrifugal mud mixing unit recently installed on Penrod's Rig 3 demonstrates portability of independently-driven and skid-mounted unit. Six-inch riser to mud tank is discharge line.



Dual centrifugal pumps in background can be paralleled or can handle separate fluid transfer jobs. This unit on Rig 3 incorporates new piping design. Hopper is located between pumps and mixing tank.

should be introduced into the lantern ring connection to replenish the supply. This packing gland must not be tightened excessively or the lubricant will be squeezed out of the gland, and at the same time will prevent the lubricant from covering the entire length of the stuffing box. A regulated water or oil supply under a pressure slightly above the stuffing box pressure, or, a suitable spring-loaded grease lubricator is necessary for good shaft and packing life.

For The Drilling Crew

Some instruction is necessary for the drilling crews, accustomed to working with reciprocating pumps, to become familiar with centrifugal pump operations. For example, a centrifugal pump uses less horsepower if a valve in the discharge line is closed. In fact, it is permissible to run a centrifugal pump for a short time with the discharge completely closed. This is an added safety feature over conventional high-pressure systems, which in one case resulted in the death of one crewman.

Operations are flexible. The main job for these centrifugal pump hookups is to mix mud and stir the mud tanks. But, they are used effectively to quickly fillup the casing or hole, transfer mud, charge rig pump suctions, and pump water. With the dual pump hookup described, it is possible to pump water with one unit while mixing mud with the other. This is not possible with conventional mud mixing units.

Lower investment and better job . . . are two attractive features of this dual centrifugal pump hookup. It may be a small, but significant development in view of the economics of contract drilling today. Ideas such as this enable the contractor to reduce capital investment while at the same time improving his operations.

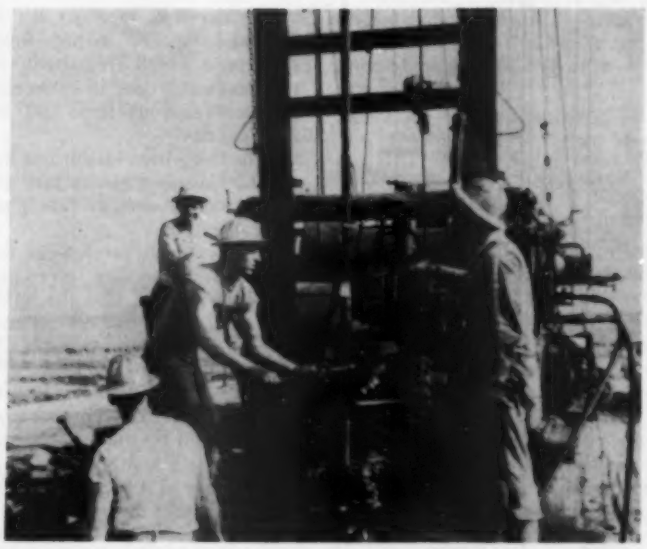
Acknowledgment

Thanks go to the management of Penrod Drilling Company of Dallas, Texas, for information and data, and for permission to publish this report; and to Mission Manufacturing Company of Houston, Texas, who participated in this development and furnished photos, diagrams and data. ★ ★

WHAT ABOUT GAS LIFTING TUBINGLESS COMPLETIONS?

PURVIS J. THRASH,
Division Gas Lift Engineer,
Otis Engineering Corp.,
Corpus Christi, Texas

Here are answers to ten important questions you should ask yourself about this relatively new cost-saving completion method



Workover crew installs 1½-in. integral-joint tubing with full opening 1¼-in. gas lift valves in a new well equipped with 2⅞-in. OD casing.

CAN YOU gas lift a well completed with ¾ to 1½-in. tubing inside 2⅞ or 2⅜-in. casing? This is the big question producers are asking as a result of the closer look at tubingless completions which offer unusual economic advantages.

Since there is a definite trend to more and more small-diameter cased wells that may flow upon original completion, the operator must look ultimately to the day when such wells will require artificial lift. What then?

Although equipment and methods for tubingless completions are constantly undergoing continued research and development, considerable field data and experience definitely show that gas lifting is feasible, practical and mechanical requirements can be met now.

Can you answer these ten big questions? For an efficient installation that will meet adequately future operations, the following questions must be carefully considered even at the time of the original completion before the need arises:

1. Is gas lift practical with small diameter tubing (¾, 1, 1¼ and 1½-in.)?
2. Should tubing or annular flow be used?
3. Will gas lift valves be needed or will it be satisfactory to blow around the bottom of the tubing?
4. What will be the maximum expected daily gross fluid production?
5. What size tubing should be used?
6. How deep should small tubing be installed for gas lift?
7. How will valve spacings and valve pressure settings vary from conventional gas lift installations?
8. Is it possible to perform wireline work through small tubing with gas lift valves in the string?
9. Should a packer be installed on the bottom of the small tubing?
10. What are the prospects of dually producing a tubingless completion using gas lift for one or both zones?

Is Gas Lift Practical in Small Diameter Tubing?

For several years small tubing and valves for "macaroni" gas lift in 2⅜ and 2⅞-in. tubing has become widespread and their use is increasing. In many cases such installations have been utilized to lift one zone of a concentric dual as shown in Fig. 1. In other cases, "macaroni" tubing and valves have been installed to lift one or more zones of a multiple completion with parallel strings of 2⅜-in. tubing shown in Fig. 2.

In offshore or other wells not easily accessible, small tubing and valves have been lowered into single zone producers to eliminate the high cost of pulling the regular tubing to install valves. At times, bad casing in a well will be "patched" by leaving the regular tubing and packer in place. The well can then be gas lifted through small diameter tubing equipped with valves and inserted inside the regular tubing.

Volumes lifted more than expected. It is important to have a clear understanding of the capabilities of such installations and the selection of equipment be more closely analyzed.

Results obtained todate in the widespread use of "macaroni" tubing and valves have been considered successful. Resulting gross fluid production and lift efficiencies have been higher than once thought possible, as demonstrated by actual production data compiled in Table 1.

Another important consideration is the availability of pipe and necessary tools with which to complete a well in this manner. Manufacturers of oil field equipment, always alert for new developments, have more than adequately kept up with this trend to small diameter pipe. Tubing, gas lift valves, wireline tools, packers, and wellhead equipment are available. Work-over contractors and tool rental companies have equipped themselves in most cases with the necessary tools needed to run and pull these "miniature" tubing sizes.

ABOUT THE AUTHOR

Purvis J. Thrash is division gas lift engineer of the Southwest Texas Division of Otis Engineering Corporation. He headquarters at Corpus Christi, Texas. He was graduated from Texas A & M College in 1950 with a BS degree in Petroleum Engineering. A native of Nacogdoches, Texas, he attended Ball High School in Galveston, Texas. He has worked for Pan American Pipe Line Company. Since the early 1950's, he has specialized in gas lift engineering and design as well as production automation prior to joining Otis in 1958. He is a member of the Society of Petroleum Engineers of AIME, and has talked on gas lift before local AIME Study Groups.

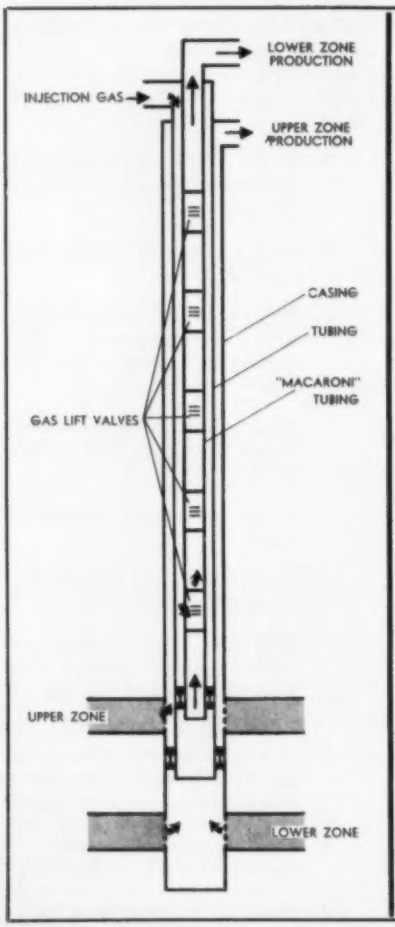


FIG. 1. **Small-diameter tubing** and valves to lift one zone of a concentric tubing-type dual completion.

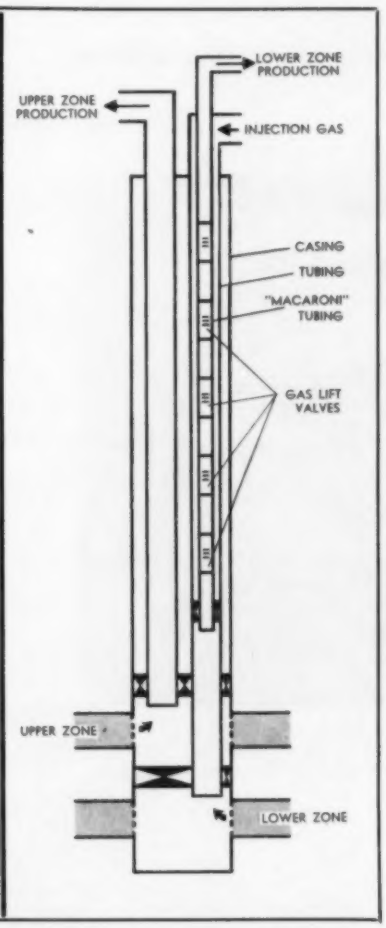


FIG. 2. **Parallel strings** for dual zones where one string is equipped with gas lift valves.

Tubing Flow or Annular Flow?

Annular flow type gas lift is used with some success in high fluid level wells having high productivity characteristics and where it is necessary to produce relatively large quantities of fluid per day.

It has long been established that tubing lift is more satisfactory in most cases than is annular lift. There are several reasons:

1. For given production rates on continuous flow, more gas must be injected into the annulus to set up a gradient whereby the necessary drawdown is achieved at the formation face.
2. In intermittent type gas lift, the fluid head is consistently interrupted by the ever-changing annular cross sectional area and shape as it ascends. Further, it is agitated by encountering coupling edges when coupled tubing is used.
3. The ill effects of corrosion and erosion are not confined to the inner surface of the tubing. Instead, both the interior of the casing and the exterior of the tubing are subject to damage in annular flow.
4. Paraffin deposition cannot be controlled or removed as effectively when lifting through the annulus.

Table 1. Relatively Large Volumes of Gross Fluid Can Be Gas Lifted as These Data Indicate on "Macaroni" String Installations.

Well	Nominal Macaroni Tubing Size ID (In.)	Nominal Tubing Size ID (In.)	Nominal Casing Size OD (In.)	Type of Flow (Tbg. or Annular)	Depth of Gas Injection (Ft)	Packer Depth (Ft)	Surface Operating Gas Pressure (Psi)	Gross Production (Bfpd)	Net Production (Bopd)	Method of Lift (CF or INT)	Gross Input Gas/Fluid Ft³ per bbl
A	1	2	5½	annular	2050	none	800	125	65	CF	238
B	1	2	5½	annular	2065	none	800	91	45	CF	167
C	1	2	7	annular	3502	none	540	90	73	INT	1215
D	1	2½	5½	annular	unknown	none	530	499	35	CF	238
*E	1		2½	annular	1570	none	775	80	22	CF	1060
F	1	2	7	tubing	6012	6117	450	37	30	CF	1590
G	1	2	5½	tubing	2100	3742	795	198	18	CF	990
H	1	2	5½	tubing	1820	4860	830	100	10	CF	130
I	1	2	5½	tubing	5000	5530	700	34	14	INT	532
J	1	2	5½	tubing	unknown	4959	550	50	28	INT	730
K	1	2	5½	tubing	4132	4990	850	92	83	INT	1190
L	1	2	7	tubing	5450	5500	730	43	42	INT	2790
M	1	2	7	tubing	3100	5500	880	161	141	INT	820
N	1	2	7	tubing	3600	5500	880	93	75	INT	1870
O	1	2	5½	tubing	5004	5532	705	50	16	INT	1215
*P	1¼		2½	tubing	4420	4500	800	322	0	CF	351
*Q	1¼		2½	tubing	2500	3930	550	393	12	CF	200
R	1¼	2½	5½	tubing	unknown	none	550	513	21	CF	125
*S	1¼		2½	tubing	2500	3920	550	352	11	CF	250
*T	1¼		2½	tubing	1500	none	450	103	trace	CF	79
**U	1¼	2½	7	tubing	2980	3000	650	300	171	CF	333
V	1½	none	5½	tubing	9265	9300	670	66	45	INT	1546
*W	1½		2½	tubing	3000	4000	550	113	78	CF	575
X	1½	2½	7	tubing	4000	9295	580	222	19	CF	421
Y	1½	none	5½	tubing	8251	9500	650	89	40	INT	1825

*Tubingless completion.
**This well is being lifted through a 1¼-in. storm choke above the upper most valve and into a 230-psi separator system.

These considerations for selecting tubing flow in preference to annular flow in conventional gas lift practices also hold true for "tubingless completions." Annular flow has been used with success in high fluid level, high productivity wells. However, the selection of a larger tubing size (Example: 1½-in. instead of 1-in. inside 2⅞-in. would produce large quantities of fluid efficiently and with less danger to the casing.

Gas Lift Valves or Blow Around Bottom?

In some cases, tubing without valves will lift a well, but, in the majority of cases, the use of gas lift valves will:

1. Expedite unloading the well fluids when "kicking the well off" and working down to operating level.
2. Increase lifting efficiency by allowing gas to be injected into the flow stream at the most desirable depth and in conservative quantities.
3. Eliminate the need for relocating the depth of the tubing string to adjust for changing well conditions.
4. Reduce damage to the casing by abrasives carried in the well fluids.

Gross Fluid Volumes Expected

With some special exceptions, cases noted indicate that in general the following gross fluid volumes can be expected when lifting through macaroni strings:

Nominal Tubing I.D.-in.	Normal Maximum Gas Lift Gross Production — BFPD
¾	150-200
1	250-300
1¼	450-500
1½	850-900

These volumes apply to high fluid level, high productivity formations, and continuous flow operations. It should not matter appreciably in what manner the tubing is installed. It may be inside of 2⅜-in., inside of 2⅞-in. or in some single or parallel dual installation.

These figures would be affected by flow restrictions due to chokes, excessive turns in the flow line, high separator pressure and equipment in the tubing string.

What Size Tubing Should Be Used?

Several choices are available in "tubingless completions." Of course, the range of choices is greater for 2⅞-in. pipe than for 2⅜-in. pipe.

¾-in. NON EU. This size tubing may be considered for annular flow inside of 2⅜ or 2⅞-in. pipe. However, this would be restricted only to high fluid level, high productivity wells and the disadvantages of annular flow are so numerous that it would be well to consider instead, the use of larger tubing sizes for tubing flow. Under certain conditions ¾-in. NON EU or integral joint tubing may be used successfully for tubing lift inside of 1½-in. pipe.

¾-in. EU. This particular pipe does not appear to have wide application. Tensile strength of the pipe is not normally required and the coupling OD is such that, if annular flow is to be achieved, then ¾-in. NON EU will probably serve the purpose better.

1-in. NON EU. For shallow and moderately deep lift 1-in. NON EU appears to be the best all-round choice for use in 2⅜-in. pipe. It is suitable for both continuous flow and intermittent lift.

1-in. Integral Joint. For tubing flow inside of 2⅜-in. pipe, 1-in. tubing is the best all purpose selection. However, 1-in. NON EU will serve the purpose very nicely even for moderately deep lift (5000 to 6000 ft). It is possible that, for deep lift (greater than 6000 ft), added clearance for gas passage afforded by the small OD of the integral joint may be helpful.

1-in. EU. This is another size pipe

that does not appear to be best suited for any particular gas lift application in small diameter casing. The extra tensile strength is not usually required and the coupling OD (1.9 in.) is somewhat of a drawback for use in 2⅜-in. pipe.

1¼-in. NON EU. This size pipe is probably the most versatile for gas lifting inside of 2⅞-in. pipe. It is suitable for both continuous flow and intermitting type operations. Also, it has application in 2⅜-in. pipe as noted below.

1¼-in. NON EU with couplings turned down is used inside 2⅜-in. pipe to lift high fluid level, high productivity wells. This type application is capable of higher production rates than 1-in. tubing. It is not considered suitable for intermitting in 2⅜-in. due to the small clearance for gas passage around the couplings.

1¼-in. Integral Joint. When small diameter tubing is to be used to lift a high fluid level, high productivity well in 2⅜-in. pipe, 1¼-in. tubing is probably the best choice. However, the use of 1¼-in. NON EU with coupling OD's turned down will suffice in many instances and may be cheaper. For extremely deep intermittent lift in 2⅞-in. pipe, 1¼-in. integral joint may be useful.

1¼-in. EU does not seem to offer any particular advantages for gas lifting inside of 2⅞-in. tubing. The choice of 1¼-in. integral joint for deep lift, 1¼-in. NON EU for moderately deep lift, and 1½-in. integral joint or 1½-in. NON EU for shallow high productivity lift, appear to be better suited for gas lifting inside of 2⅞-in. pipe.

1½-in. Integral Joint may be used to advantage in many cases where 1¼-in. NON EU tubing first appears to be a good choice. For gas lifting moderately deep wells inside of 2⅞-in. tubing, the 1½-in. pipe holds the possibility of a somewhat greater ejection rate than 1¼-in. in both continuous and intermitting flow. It would be satisfactory also for lifting high fluid level, high productivity wells inside of 2⅞-in. pipe. But, 1½-in. NON EU also would do the job.

1½-in. NON EU is a good choice for continuous flowing maximum quantities of fluid inside of 2⅞-in. pipe in wells having high productivity characteristics.

Desirable combinations. For gas lifting inside 2⅜-in. pipe, 1-in. NON EU tubing is a most versatile choice. But, where high productivity wells are to be lifted and maximum daily gross production is required, then 1¼-in. NON EU with couplings turned down, or 1¼-in. integral joint tubing should be a better choice.

For lifting in 2⅞-in. pipe, the choice of 1¼-in. NON EU or integral joint tubing should give a high degree of versatility. But, consideration should be given to 1½-in. integral joint where larger ejection rates are desired. The selection of 1½-in. NON EU for continuous flow in high productivity wells is also a good choice.

How Deep Should Small Tubing Be Set?

This is one of the more difficult questions to answer. With well characteristics in mind, design both for present and future requirements is necessary.

Gas lift is used first in many wells just to unload workover fluids. These fluids are unloaded to some depth whereby sufficient differential exists between formation pressure and bottom-hole pressure to cause the well to "come in." The necessary differential varies widely, but in many cases such as this, the well will clean-up and flow naturally after being brought in by this procedure. Sand, lost drilling fluids, and other formation contaminants are flushed from the well. These conditions dictate to what depth tubing should be installed for gas lift.

Where "unloading depth" is of no consequence, another approach seems more appropriate. If possible, the ability of a proposed gas lift installation to lift fluids must be evaluated and compared to the present and future ability of the well to produce fluids. By so doing, conclusions concerning what size pipe to install for tubing and how deep it should be located can be determined. In many cases, production allowable prospects are important and serve to influence installation design.

Gas Lift by Intermittent Flow

Many wells on continuous flow gas lift with small tubing produce only 20 bbl per day. Wells on continuous flow in one area produce 5 to 10 bbl per day from 1000 ft with ½-in. tubing. This type flow was more effective than the use of chambers on intermittent flow. However, these installations represent an exceptional case.

Calculations for intermittent flow. The approach taken here is to calculate the ability of the gas lift installation to lift quantities of fluid disregarding productivity of the producing formation.

Capabilities of small diameter tubing intermitting operation under certain conditions are given in Fig. 3, 4, and 5. These curves are empirical because certain values found consistent with field performance were used. Calculations were made using this equation:

$$V_t = \frac{1440\,C\,(P_v - D_f)\,(1 - 0.01\,D_v L)}{G\,D_v\,C_t} \quad \ldots\ldots\ldots \quad (1)$$

Where:

V_t = Gross fluid production in bbl per 24 hr.

C = Tubing volumetric capacity in bbl per ft.

P_v = Gas pressure to open valve under operating conditions, psi. (A pressure-operated balanced valve having a dome charged with a perfect gas will be used in this example.)

D_f = Differential across valve at time of opening, psi (a differential of 100 psi is used here).

D_v = Depth of operating valve, thousands of ft.

L = Percent "fallback" loss due to friction, percent per 1000 ft. (7 percent per 1000 ft is used for all tubing sizes in the examples of this paper.)

G = Gradient of well fluid, psi per ft. (A fresh water gradient of 0.433 psi per ft will be used for easy conversion by either gradient or specific gravity correction.)

C_t = Minimum possible cycle time, minutes per 1000 ft. (3 minutes per 1000 ft empirically arrived at for calculations.)

It can be argued that values selected for L and C_t will vary with existing conditions of available gas pressure, tubing size, type of gas lift valves and port sizes, etc. Since the intent here is to suggest a possible approach to answering a general question, it is felt that the values empirically determined are reasonable.

Sample Calculation:

How much daily production is a 500 psi (at a base temperature of 80 F) pressure-operated, balanced gas lift valve installed on 1¼-in. tubing at a depth of 6000 ft capable of ejecting? The well has a thermal gradient of 17 F per 1000 ft and a mean average surface temperature of 80 F. Well fluid gradient is 0.433 psi per ft.

Solution:

$$V_t = \frac{(1440 \text{ Min/Day})\ (0.00185 \text{ bbl/ft}) \left(\frac{515 \times 642}{540} - 100\right) (1 - 0.01 \times 6 \times 7)}{(0.443 \text{ psi/ft})\ (6 \times 3)}$$

$$= 101.5 \text{ bbl/day}$$

Calculated ejection rates of pressure-operated valves with various dome pressures (at base temperature) versus depth will supply useful curves. Fig. 3, 4, and 5 may be used to aid in the selection of a tubing size and in deciding how deep to install it if the conditions selected here are kept in mind and necessary corrections made as required.

Valve Spacing and Pressure Settings

Unloading gradients for specific flow rates are the manner in which expected productivity indices are introduced into spacing formulas. These gradients will be higher in small tubing than in the larger sizes for the same flow rates. For this reason, valves will be spaced somewhat closer together in small tubing.

A common field practice of setting 25-50 psi differences between opening pressures when using pressure-operated valves seems to be satisfactory. Gas flow calculations would indicate that pressure differences could vary somewhat depending upon the flow course which conducts gas to the valves. It is probable that pressure setting differences in a continuous flow situation would not be the same as in intermittent flow.

For the pressure-operated, balanced valve, 50 psi has been widely used with success and seems to provide versatility with safety from valve interference under operating conditions.

One factor of concern is that of pressure loss. The type of valve being run influences valve settings. A difference of 25-50 psi is recommended for a balanced valve in particular. By balanced is meant a valve that is not affected by tubing pressure. Some operators run valves set at the same or increasing pressures. These are increased shop settings at 60 F and not increased surface operating pressures.

To illustrate this point, assume two valves, one balanced, the other being effected 20 psi per 100 psi from tubing pressure effect. Both are set to open at 800 psi at well temperature of 150 F in the test rack (no tubing pressure). Now both valves are placed in the same well at 500 ft where a 600 psi tubing pressure exists and the temperature is 150 F. The balanced valve still opens at 800 psi whereas the unbalanced valve now opens at:

$$800 \text{ psi} - \frac{600}{100} \times 20 = (800 - 120) = 680 \text{ psi}$$

It is quite possible that balanced valves taking a 25 psi drop in pressure will operate at depth with a higher surface pressure than valves incorporating a back pressure effect set at the same pressure or increasing pressures. However, even an unbalanced valve should take some drop in pressure in macaroni installations. For small gas volume spaces, a so-called "stacking" of gas pressure occurs which will "pop open" upper valves. This may be troublesome for intermittent wells. A recommended practice is to choke the injection gas downstream from the intermittent controller using a choke approximately the size of the port in the operating valve.

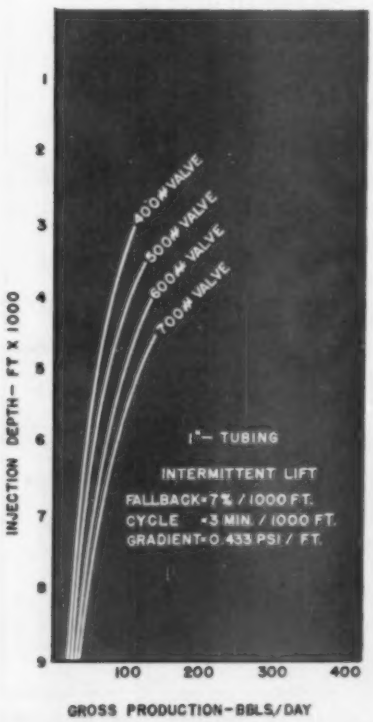


FIG. 3. **Lifting capabilities** of small diameter tubing for intermittent operations, using 1-in. tubing.

FIG. 4. **Intermittent gas lift capabilities through 1¼-in. tubing.**

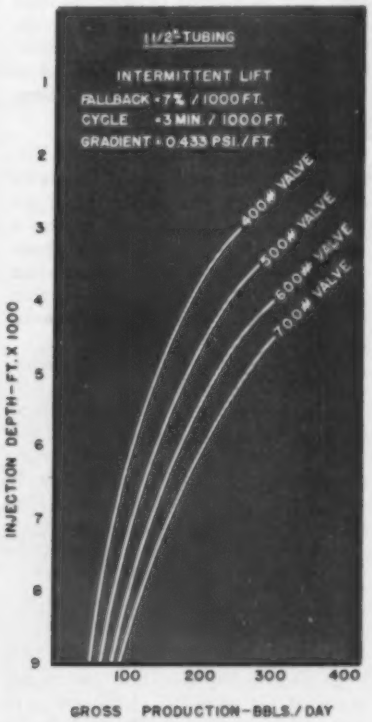


FIG. 5. **Capability of 1½-in. tubing** for intermittent gas lift.

What About Wireline Workovers?

Concentric, full-opening gas lift valves for small tubing sizes are relatively new, but are currently available. A full opening 1¼-in. valve, recently developed, shows promise of versatility in 2⅞-in. tubingless completions. It is a pressure-operated, balanced valve capable of performing efficiently in both continuous flow and intermitting operation.

Other 1¼-in. wireline tools are also available for installation in conjunction with these gas lift valves in the tubing string. Some of these wireline tools are: (1) selective landing nipples, (2) wireline retrievable tubing plugs, (3) side-door chokes, and (4) full-opening sliding side-door valves.

Another size valve, having a full opening of 1½-in. ID and external dimensions suitable for installation inside of 2⅞-in. pipe also shows promise for certain lift conditions with 1½-in. tubing. Conventional wireline tools are also available in 1½-in. sizes.

Typical tubingless completion.

A typical South Texas "tubingless" gas lift completion is illustrated in Fig. 6. Here 1½-in. integral joint tubing is equipped with full opening 1¼-in. ID gas lift valves. A 1¼-in. ID sliding side-door valve is located below the valves and immediately above the packer. At a later date, the sliding side-door may be opened by wireline tools and the well safely loaded with workover fluid before unseating the packer. Full opening 1½-in. ID gas lift valves has also been used in this type of completion.

Should a packer be used on the bottom of macaroni tubing? Yes, wherever practical. As in any conventional gas lift installation, a packed-off annulus is desired because it permits more positive volumetric control. It has the same operational advantages in tubingless completions as it offers in conventional gas lift completions.

Profiled, selective landing nipples, when strategically installed in the casing of a tubingless completion, can be useful. One example of this is a "locator" assembly that is run on the bottom of the macaroni tubing and selectively seats in any landing nipple desired. The chevron packing of this locator seats against the honed inner surface of the landing nipple and serves as a packer.

Can You Gas Lift Dual Completions?

In some cases, more than one casing string of 2⅜ or 2⅞-in. is cemented in the same hole. For gas lift, each casing string is a different well. Macaroni tubing in one casing string in no way affects operations pertaining to the other zones (Fig. 7). Dual completions inside individual 2⅞-in. tubing are a reality in South Texas and other areas. But, dual completion with gas lift can only be speculated on, since, to the author's knowledge, this has not yet been attempted.

This in no way implies that dual completions with gas lift cannot or will not be attempted.

Some possibilities are:

1. Concentric gas lift valves of specific sizes are already in various stages of design and manufacturing. Gas lift of one zone only would be possible using ¾-in. tubing and valves inside of 1½-in. tubing (preferably integral joint) and allowing the stronger zone to flow naturally through the 1½-in. tubing by 2½-in. casing annulus.

2. What about simultaneously lifting two zones? Here again, speculating on things to come, it is not improbable that, under certain conditions, annular flow valves could be installed on the 1½-in. for lifting one zone through the 1½ by 2⅞-in. annulus. Simultaneously, tubing flow valves on the ¾-in. tubing inside of the 1½-in. would lift the second zone. Both valve strings would be supplied gas through the ¾ by 1½-in. annular space.

Additional information and research in this area would be beneficial. Evaluation of correct gradients for small pipe has not been achieved in all sizes to the satisfaction of everyone. In particular, intermittent flow information should be extended so that slippage, friction, and port sizes may be evaluated more fully.

Acknowledgments

The author thanks the many oil company engineers in South Texas who assisted in gathering essential data. Additionally, a word of thanks is due Kermit E. Brown, Professor of Petroleum Engineering, The University of Texas, for his worthy contributions and assistance. ★ ★ ★

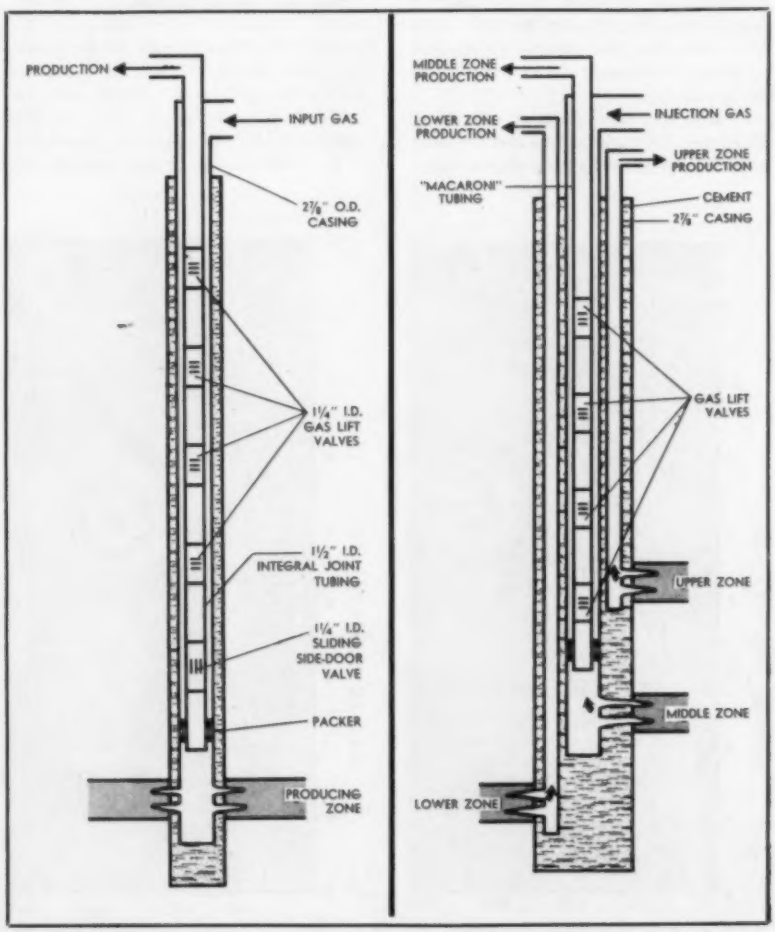


FIG. 6. **Typical tubingless completion** for South Texas with 1¼-in. gas lift valves and a sliding side-door valve (wireline operated) to provide for circulation.

FIG. 7. **Multiple completion** with small diameter tubing where two zones flow and one zone is to be gas lifted.

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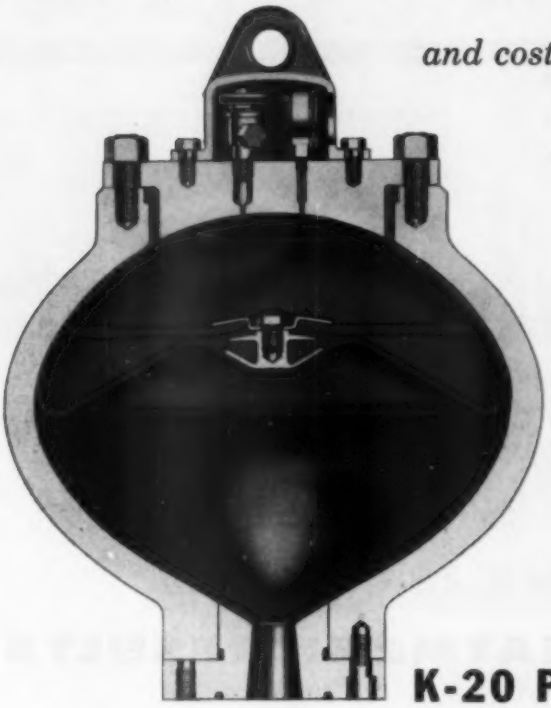

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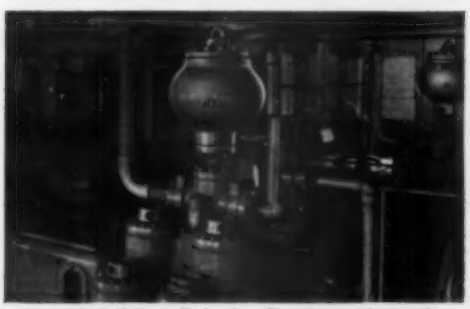

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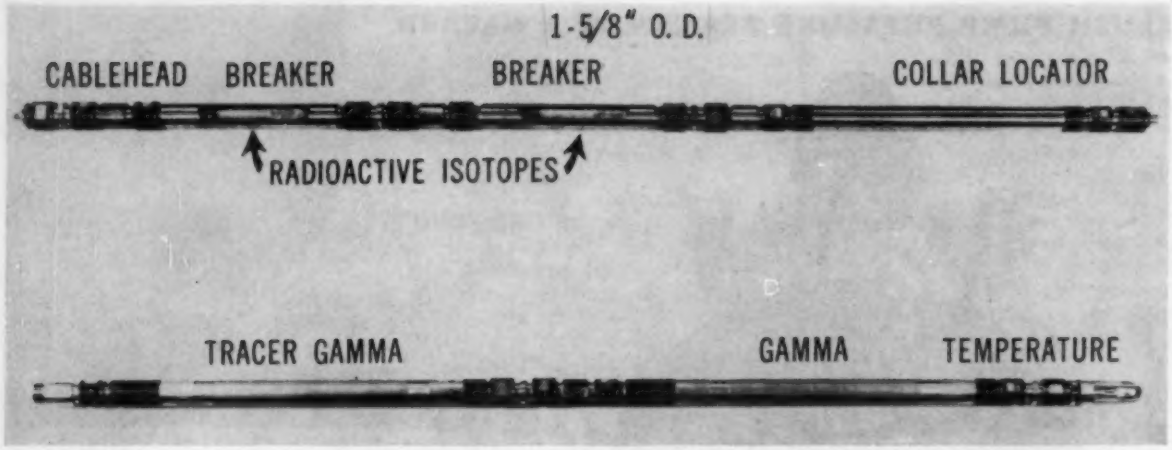

FIG. 1. **Combination subsurface tracer tool** used to perform the surveys for the statistical study shown in Table 1. This is the only down-the-hole tool used to perform the complete survey.

RADIOACTIVE ISOTOPES TRACE WELL TREATMENT RESULTS

W. E. JOHNSON
Birdwell, Division of Seismograph Service Corporation
Tulsa, Oklahoma

Although the use of radioactive material to trace down-the-hole injection treatments is not new, this method continues to be improved and used more widely. The results of 72 tracer surveys in the general Illinois Basin area, again confirms the potential and usefulness of this method.

THE ROLE of nuclear energy in the exploration, development and operational phases of the oil and gas industry is becoming an increasingly important means by which many of the industry's reservoir problems are being made easier to solve.

The extent to which the atom can be used to reveal unknowns is limited only by man's ingenuity in developing tools and techniques that will permit him to explore and expose these secrets.

Radioactive isotopes are being used daily to evaluate zones of injectivity, zones of productivity and abnormalties in well completion and operation. The part that isotopes play in determining the vertical extent of hydraulic fracture treatments through perforations will be briefly discussed in this paper.

Radioactive isotopes have been used to solve various oil production problems since 1949. In 1953, a radioactive tracer was successfully used to determine the vertical extent of the fracture treatment in one of the first wells to be hydraulically fractured in the Appalachian area. Techniques have been improved to the point where tracers run in conjunction with or after hydraulic fracturing will show within a foot or two, where breakdown, fracturing or channeling has occurred. The survey depths can be adjusted to the electric or other primary log measurements by proper correlation procedures.

The basic function of radioactive isotopes, as they are being used in oil field tracer work today, is to emit gamma radiation which can be detected and recorded by wire line equipment. If the proper techniques are employed, it is possible to determine abnormalties which occur during the completion and operations of oil producing or water injection wells. Although small quantities of natural gamma radiation are emitted from all earth formation, sufficient quantities of isotopes are introduced during the survey to completely mask any effect of the natural radiation.

Equipment Used and Types of Surveys

Subsurface equipment used for most tracer surveys is a "collar locator-breaker-tracer-temperature" combination tool 1⅝ in. in diam as shown in Fig. 1. A recess near the top of the tool accommodates a vial of tracer material which can be broken at any predetermined depth by a small explosive cap. Near the lower end of the tool is located a radiation detector and at the very bottom a thermistor for temperature logging. After the radioactive material is released, the radiation detector is utilized to detect the position and quantity of tracer material at any level in the well. The temperature detector and the collar locator may be used for obtaining supplemental information.

Tracers are of two general types. One type tracer uses radioactive particles insoluble in oil, water or acid. The other type is a radioactive solution.

In hydraulic fracturing, the solution

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tracer survey can be further classified into (1) the "break-down" tracer and (2) the "follow-up" tracer.

"Break-down" tracers are solution tracer surveys conducted immediately after the formation has been broken down by hydraulic pressure, but prior to the sand treatment phase.

"Follow-up" tracers may be defined as solution tracer surveys conducted after hydraulic fracturing or acidizing has failed to stimulate oil production and where, instead of oil, unaccountable volumes of water enter the well.

"Frac" tracers are those where tagged radioactive particles (beads), insoluble in oil, water or acid, are introduced into the well with the sand treatment and the final position of the tagged material in the well is determined at some time following the frac.

Breakdown Tracer

During the breakdown tracer survey a vial of radioactive liquid is released at any desired depth. While fluid is being injected into the well, a series of logging runs is made through the radioactive material as it moves with the fluid down the pipe and out the perforations. If breakdown has occurred in the zone of interest and no serious "out-of-zone" breakdown or channeling is indicated, then the sand treatment is performed. However, if "out-of-zone" breakdown or channeling has been extended to formations which are known to be water bearing, then the sand treatment may be postponed while remedial measures are performed. Remedial measures usually include a cement squeeze and reperforating for another attempt to break down and fracture the zone of interest.

A breakdown tracer survey, in the event of "out-of-zone" breakdown or channeling, will allow for postponement of the sand treatment with a savings in service and material costs, along with the elimination of possible damage to the well. Remedial work in such a case is more successful because it will permit better sealing of shorter fractures by the cement without the frac sand in the fractures.

Frac Tracer

Prior to a frac tracer survey, radioactive isotope impregnated plastic beads are pumped into the well with the sand treatment. The radioactive material is carried with the sand into the fractures or channels created by the fracturing process. It remains there until such time as it is convenient to make a survey. The time limit that a frac tracer survey can be made after placement of the beads, depends on the half life of the isotope being used. With isotopes currently being used, successful surveys can be made within about six weeks after placement of the radioactive material in the well.

Fig. 2 shows a frac tracer survey indicating channeling above and below the perforated interval.

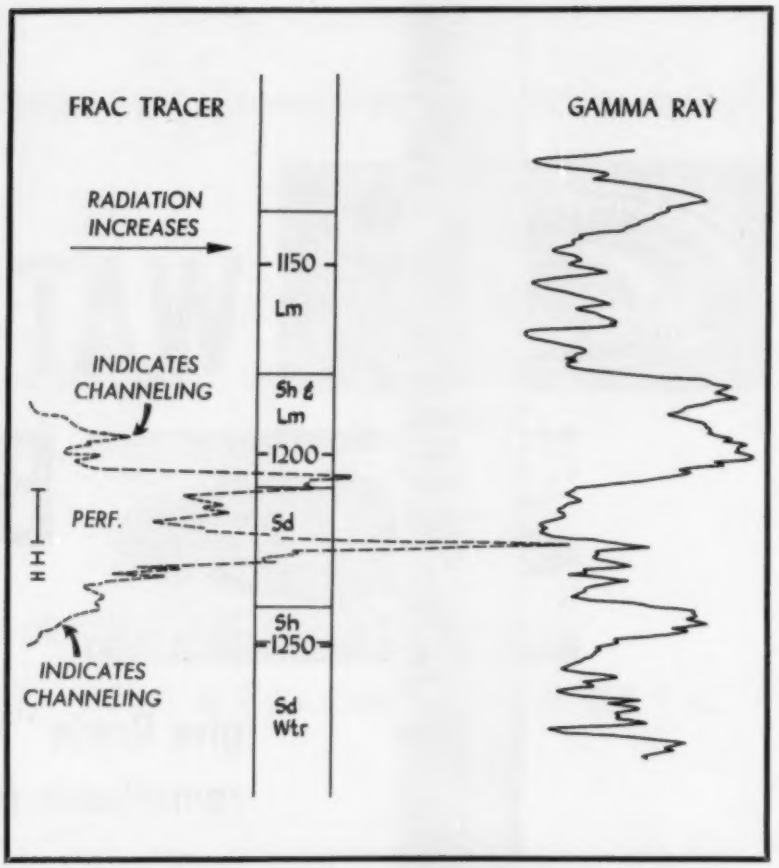

FIG. 2 logs a "Frac" tracer survey. The presence of radioactive particles mixed with the fracturing solids at points 20 ft above and 17 ft below the perforated interval, definitely indicates channeling of the fracturing material outside the zone desired to be treated.

Follow-up Tracer

During the "follow-up" tracer, a vial of radioactive liquid is released at a predetermined depth, while fluid (usually water) is injected into the well. The movement of the radioactive material is detected and recorded. A series of surveys is made while the radioactive material moves to that part of the well where fracturing and/or channeling has occurred. When the survey is completed and properly evaluated it will reveal whether the source of water is from the zone of interest or from a water bearing formation either above or below the zone of interest. Fig. 3 shows a "follow-up" tracer survey where channeling behind

TABLE 1. A Statistical Study in the Illinois Basin of the Success of Hydraulic Fracturing Through Perforated Intervals.

Survey Type	Number of Surveys	Distance in Feet Above or Below the Perforated Interval That Fracturing or Channeling Occurred						Results of Frac Treatment		
		Above		Below		Average		Successful	Unsuccessful	Questionable
		Min.	Max.	Min.	Max.	Above	Below			
Breakdown	12	0	50	0	60	10.7	15.3	4	6	2
Breakdown and Frac	11	1	42	0	22	11.4	9.8	7	3	1
Frac	5	0	19	6	16	9.0	12.2	3	0	2
Totals	28					10.7	12.6	14 (50%)	9 (32%)	5 (18%)
Follow-up	44	0	320	0	79	20.8	21.8	2 (4%)	41 (94%)	1 (2%)
Total Surveys	72									

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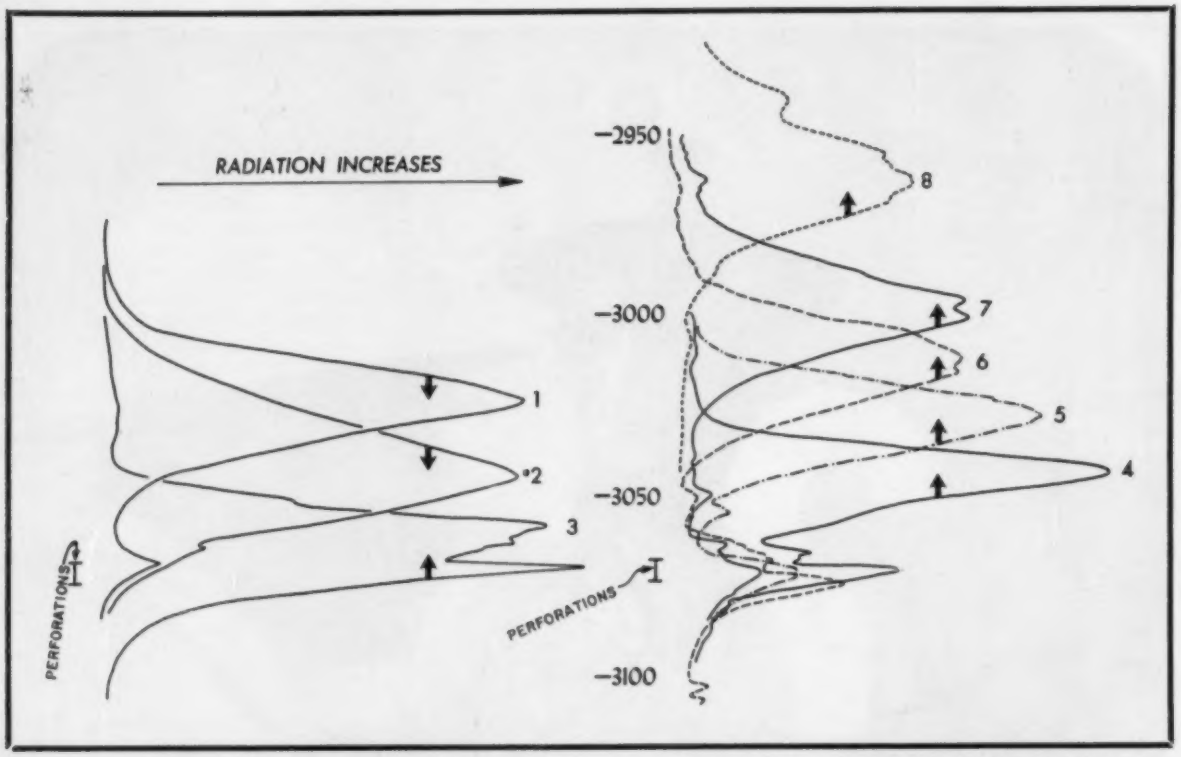

FIG. 3 records 8 gamma log runs on a "follow-up" type survey. Run 1 starts some 75 to 100 ft above the perforations and after the radioactive isotope solution has been ejected from the logging tool. In the subsequent runs, the radioactive solution is traced by the gamma logging tool as it is pumped down the hole, out of the perforations and into the formation. As shown by run number 8, channeling up the hole was very serious, indicating an ineffective cement job.

the pipe, because of an ineffective cement job, is indicated.

Statistical Tracer Study

A statistical study of radioactive tracer surveys run on a number of hydraulically fractured wells throughout the Illinois Basin provides some revealing data on the success or failure of fracturing treatments conducted on these wells. Table 1 shows the results of fracture treatments through perforations on this group of wells.

In all cases there was evidence of fractures or channels either above or below the perforated interval with the majority of wells showing fracturing or channeling both above and below the perforated interval.

"Breakdown" and "Frac" type tracer data show that channeling extended as much as 50 ft above and 60 ft below the perforated interval, with an average of 10.7 ft above and 12.6 ft below. Many of these channels extended into water bearing formations which resulted in high water production with little or no oil production.

On the basis of the data obtained from "breakdown" and "frac" tracers the results of the fracturing treatments for these wells were labeled as follows: Successful 50%; Unsuccessful 32%; Questionable 18%.

Fractures labeled successful were those that fractured within the zone of interest, and also those whose fractures or channels extended above or below the perforated zone but did not extend into "out-of-zone" water productive formations.

Unsuccessful jobs were those that fractured or channeled out-of-zone resulting in the production of "out-of-zone" water.

Questionable jobs were those that fractured or channeled out-of-zone with the produced water conceivably coming from "in-zone" or "out-of-zone" formations.

The data from "follow-up" tracer surveys, obtained at wells known to be problem wells before the survey was run, show that channeling extended as much as 320 ft above and 79 ft below the perforated interval. An average for all such surveys indicates fracturing or channeling 20.8 ft above and 21.8 below the perforated zone.

On the basis of data obtained from "follow-up" surveys the results of the fracturing treatments for these wells were labeled as follows: Successful 4%; Unsuccessful 94%; Questionable 2%.

It should be pointed out that the results indicated by the "breakdown" and "frac" tracer surveys are more nearly representative of fracturing results to be expected in the Illinois Basin.

The reasons for failure in fracturing through perforated zones point most heavily toward well conditions that lend to poor bonding of cement to the pipe and to the formation. Conditions such as drilling mud still adhering to the pipe or to the formation after cementing, "green" cement, or no cement behind the pipe are the most common causes.

In formations where there is a "bottom water" transition zone below the oil productive zone, perforating too close to the water zone often results in fracturing or channeling into the water.

Conclusion

Tracer surveys can be used effectively to show the vertical extent of fracture and acidizing treatments and to indicate the source of trouble in problem wells.

If the results indicated by this data can be assumed to be representative of the overall fracturing performance in this area then the need for more carefully controlled completion methods are evident. * * *

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"Sometimes I Think We Could Treat the Oil Just by Setting a Drum of Visco on the Lease"

Reports on Emulsion-Breaker Performance with Visco 485 ... A Typical Visco Formula

Visco 485 is one of dozens of emulsion-breaker formulas that Visco has developed for specific production areas and well conditions. It has taken off like a rocket—often producing dry oil to storage on leases where tank rolling was routine . . . and proving once again that "the tough jobs go to Visco"!

Here are a few instances where Visco 485 has solved difficult treating problems—one of which led to the optimistic statement in the headline.

Rough Gas-Cut Oil and Acid Water

First 200-barrel tank from this new well had had 12 gallons of chemical and as much as 150° of heat . . . 1.0% water was still held up. Five gallons of Visco 485, and 30 minutes' rolling were all it took to sell the tank at 0.2% water.

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Retreating was common on this lease. 80 to 90 barrels of oil per day took 1½ gallons of chemical. Test of Visco 485 produced 0.1 to 0.2% water in oil with only ½ gallon per day treatment. Results are uniformly good; superintendent plans to put Visco 485 on all remaining leases in the field.

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High tank bottoms, high heat, high treating costs—then Visco 485 and Visco 958 Paraffin Inhibitor were plant tested. Chemical consumption dropped from 10 quarts/500 bbls. to one quart 485 and 2 quarts 958. Tank bottoms disappeared. Heat was lowered from 125°F. to 70°F. for a $300/month gas bill saving. Lowered treating costs with Visco are capped with better oil quality.

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Visco sells or leases Marvel Treaters as an added Visco service to producers. Detailed data will be sent promptly on request.

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Leased equipment is shown at a well in Lincoln County, West Virginia. Well is owned and operated by the Jacqueline Oil Company, Huntington, West Virginia. All equipment seen in photo is leased, including casing, tubing, pumping equipment, pump assembly, and storage tanks. Also leased, but not shown, is loading dock.

From rags to rigs . . .

FOR LEASE: Oilfield Equipment

Robert Sheridan, *President, Nationwide Leasing Company, Chicago, Illinois*

THE PETROLEUM INDUSTRY is leasing more equipment now than ever before. Last year this industry leased some $30.4 million worth of equipment, a gain of 58 percent in 12 months.

This is long-term leasing, for three years or more, and not short-term rental of equipment. Equipment being leased includes both standard drilling and pumping equipment, specialized equipment of many types, office machines, data processing equipment, refinery machinery, and virtually every type of machinery and equipment used in exploration, production, refining, and marketing of petroleum. It should be stressed that the above data refers only to income-producing equipment. It does not include cars, trucks, real estate, buildings, or railroad rolling stock, all of which are being leased in varying amounts, but which are not considered to be equipment leasing.

It may well be asked: Is this upsurge in leasing the result of a "gimmick?" Are sober businessmen falling for a fad that will fade as quickly as it bloomed?

Not in the petroleum industry and not in any other industry. Oilmen have turned to leasing because it offers them a way to increase output and profits without increasing capital expenditure. The reasons are fundamental and lie in the very structure of the oil industry's finances.

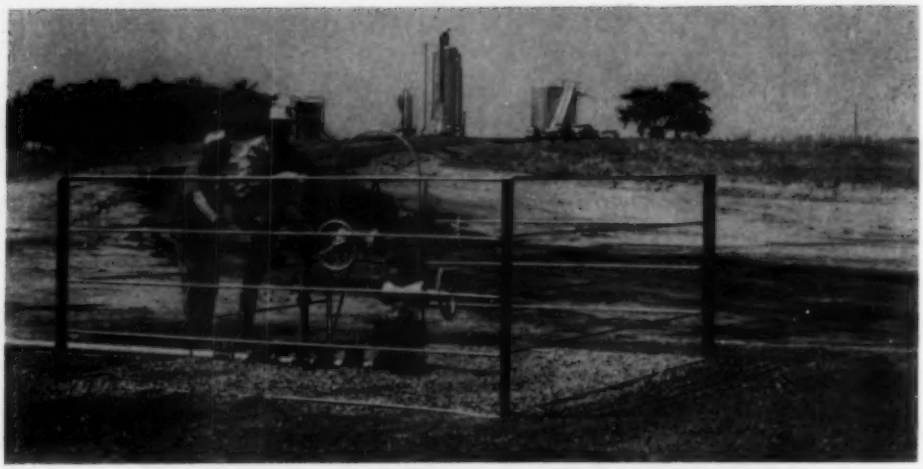
Why Lease Equipment?

Basic to the industry's problem is the need to expand output and to conduct exploration to open new oil fields in the face of an extremely high investment in fixed assets. For the average petroleum producer, fixed assets represent about 86 percent of his net worth, far and away the heaviest such investment for all manufacturing industry. At the same time, inventory represents about 71 percent of the net working capital of the typical oil producer.

These figures show an extreme tightness of working capital, which makes it difficult for companies to expand production while keeping pace with the increasing cost of newer and more complex equipment. Companies faced with this alternative have a real problem in acquiring modern equipment without overstraining their working capital resources. This indicates the main reasons why petroleum producers have increased the amount of equipment they are leasing: they receive the use of equipment without expenditure of capital and they receive long-term financing.

This is in line with the experience of other businessmen, who usually cite one or several of eight reasons why they lease equipment:

1. **Working capital is preserved.**
2. **Normal bank lines remain undisturbed.**
3. **Equipment leasing offers virtually 100 percent financing, as against a maximum of 75 or 80 percent through other methods.**
4. **Equipment is paid for out of before-tax earnings rather than after-tax profits.**
5. **Cost-cutting equipment can be installed immediately to strengthen competitive positions.**
6. **Tax-timing advantages may result.**
7. **Leasing provides a hedge against inflation and rapid obsolescence of equipment.**
8. **Long-term financing is obtained without diluting ownership or control.**



Leased gas equipment is shown at the Federal Coal Company's Well No. 1 in Nicholas County, West Virginia. Equipment leased includes casing, tubing, valves, packers, and Christmas tree.

Preservation of liquid working capital, so that it can be used to earn profits rather than be frozen in equipment, is the major reason why oilmen decide to lease.

The example of a medium-sized producer reveals the importance of this reason clearly. In its last fiscal year, the company showed an increase in sales of 40 percent. Its latest balance sheet shows current assets of $9,108,000 and current debt of $7,092,000, or a current ratio of 1.27:1.

This company recently planned new drilling operations for which it needed equipment. After careful examination of alternatives, the company decided to lease about $100,000 worth of equipment.

The overriding reason for the decision to lease was that purchase would reduce available liquid working capital. In its last published statement the company showed that it had net working capital of $1,926,000. Profits earned by this firm on net working capital were a little less than the industry average — slightly under 35 percent after taxes, or approximately 70 percent profit on net working capital *before taxes*. The industry average is about 42.5 percent after taxes, or 85 percent before taxes.

This extremely high rate of profit on net working capital — the highest by far for all industry — does not prove that the oil industry has an excessively high rate of profit. Rather does it reveal the extreme shortage of working capital, which is forced to do double and triple duty, if the industry is to earn its normal profit on invested capital and to continue its highly venturous exploration for new oil fields.

In other words, this company realized that every dollar it took away from its net liquid working capital to spend on equipment would cost 70 cents in *before-tax* profits that this net working capital could earn if used in production. In effect, then, the company would have sacrificed $70,000 in before-tax profits if it had purchased this $100,000 worth of equipment. And this is in the first year alone!

The Cost of Cash

This freeing of working capital for more profitable use is the nub of the special advantage offered by leasing.

When an oil producer acquires a piece of equipment, or several pieces totaling, say, $10,000 or any multiple thereof, the purchase cash must come from somewhere. If it comes from the company's own depreciation reserves plus an addition from working capital, that cash costs the company something.

It is true that many firms do not regard this use of their own cash as costing them anything. This may be true if a company is sitting on surplus idle cash which it cannot employ profitably in the business. This is rare. Most companies in the petroleum industry suffer from the contrary disease: not enough cash to stretch over all the obligations. When a petroleum producer takes part of his cash (from whatever fund it may be) and freezes that in fixed assets, that cash is removed from liquid working capital. Since profits are earned on liquid working capital, multiplied by annual turnover, any time a company cuts into its liquid cash, it cuts into its profit-making ability.

There is no mystery about this; it is elementary accounting. What all this boils down to is this: When a company takes liquid cash out of its current funds and ties that up in fixed assets, the company pays exactly the before-tax profit as the cost of employing that money for acquisition of equipment.

(A complete study on the costs of equipment leasing, including full cost charts, has been published by the Foundation for Management Research, entitled "The Pros and Cons of Leasing." Single copies are available free to executives by writing to the Foundation at 121 West Adams Street, Chicago 3, Illinois.)

Since, in essence, leasing is just another method of borrowing (fixed) capital for comparatively long term, an oil company has only to figure out (1) what it costs for company cash to be frozen in equipment, as against (2) whether it is cheaper to pay the leasing company to use its capital to acquire the equipment.

This is admittedly an oversimplification, but it is nonetheless accurate. For companies which don't have spare cash to sink into equipment, use of the leasing company's cash proves a great boon.

Rapid Write-Off

Another advantage cited for leasing is the rapid write-off of equipment costs. For example, pumps have a depreciable life of eight years under Schedule F. If leased for a three or five-year period, the lease cost will be written off in that three or five-year period. The same is true for all equipment, whatever the estimated depreciation period is.

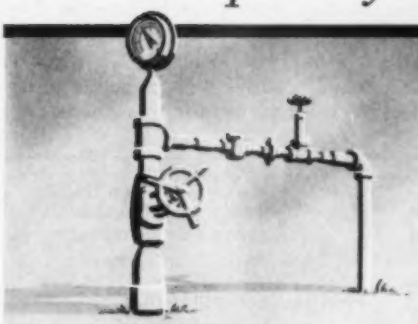
There is nothing underhanded or hazardous about that procedure. If the lease is a genuine lease, unencumbered by unrealistic purchase options, the tax law and the Internal Revenue regulations permit the taxpayer to deduct in full all lease payments which are "ordinary and necessary" to the operation of the trade or business. No ruling has ever contravened that point.

This means that pumping equipment can be written off in the lease period instead of the eight years required by the government. The same advantage is not available if the equipment is being purchased either for cash or on instalment. This is an acquisition of an asset, and in those cases, the government depreciation schedules hold.

Fast write-off means more cash flow

another
TRETOLITE SERVICE
report

Backwashing with FLUDEX *increases injection system input by 3952 barrels per day!*



INJECTION PRESSURES RETURN TO NORMAL; NO ADDITIONAL PUMPING EQUIPMENT NEEDED!

THE RESULTS:

WELL NO.	BEFORE Input bbl/day	Treating Pressure	AFTER Input bbl/day	Treating Pressure
1.	190	950	275	900
2.	400	800	810	700*
3.	120	900	900	750*
4.	165	800	900	750*
5.	100	900	950	750*
6.	60	900	110	800
7.	200	900	650	800
8.	5	900	265	750*
9.	3	950	335	450*

*Water Input Restricted by Valve.

Calcium carbonate accumulations were plaguing this nine-well injection system in Oklahoma. Formation restrictions caused increased injection pressures. (Wells completed open hole with 5-inch casing set as tubing string.)

How FLUDEX *treatment was handled*

Workover tubing string was run. Thirty barrels of water were flushed through tubing and out casing annulus. Five gallons of FLUDEX* Water Flood Additive were spotted on bottom and flushed over formation and out casing annulus by injecting 40 barrels of water through tubing. After this, five gallons of FLUDEX, mixed with 10 barrels of water, were forced into the formation and followed by 20 barrels of injection water.

This FLUDEX backwash enabled the operator to increase water injection by 3952 bpd, while maintaining desired injection pressures in the system. These larger input volumes with less pumping costs resulted in real savings.

For additional information on FLUDEX applications, contact your Tretolite Field Service Engineer.

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KR-60-1

How leasing works

A company wishing to lease equipment contacts a leasing firm and submits an application describing itself, its financial position, and naming the equipment it wishes to obtain. The company selects the supplier it wishes and arranges whatever price it can negotiate.

If the company qualifies, the process of delivering the equipment starts the day the papers are signed. Lease payments start when the equipment has been delivered.

Length of Terms

Leasing is long-term. Normally it ranges from 3 to 10 years, depending on the company and the size of the lease. Most leases fall between 3 and 5 years. Payments can be either monthly payments or tailored to any preference of the user and adjusted to any accounting system. Renewal options are available for one or more years.

Cost

The cost is the original price of the equipment, plus a small leasing charge. The entire cost is paid in the original leasing term. Renewal options are standard and are available at very low cost.

Types of Equipment

All types of equipment can be leased under a single master lease and covered by a single monthly lease payment.

Purchase Options

Purchase options are available, but not recommended. The reason is that purchase options can be interpreted by the Internal Revenue Department as converting a leasing agreement into a conditional sales contract. The effect of such an interpretation is to cost the user the benefit of deducting his full leasing charges as an operating expense.

from day to day, which is another advantage of leasing. It is for that reason that so many major companies have taken to using leased equipment in the postwar period. And it is for the same reason that smaller companies are now beginning to follow along the same path.

Generate Working Capital

How all this works might be better illustrated with actual examples. One firm operates a number of producing wells and is headed by an able and aggressive management. Recently, the company's exploration resulted in the opening of a number of new wells, which promised to add still more to the firm's income and its history of increased sales. Bringing in the new wells, however, involved additional equipment, while actually increasing the company's need for liquid working capital to handle increased expenditures for labor, materials, and other operations.

For this company also, the primary reason for leasing was to augment its strained working capital. This precise situation, however, bears particularly on one special aspect of petroleum industry financing which illustrates a specific advantage offered only by leasing.

As with any other petroleum producer, short-term bank credit plays a vital role for this company. It depends on its bank lines to support its accounts receivable, considerable material costs, payroll, and other costs that are part and parcel of operating a sizable business.

The problems involved in bringing the new wells into production were: (1) If the company took cash from its working capital to purchase equipment for the expanded operations, this would be taking it away from other profitable operations, and (2) if it used its normal bank lines to finance equipment purchases, this would reduce the amount of short-term borrowing it could do to handle the company's normal needs. And neither step would provide any additional working capital needed to carry on a larger operation.

The company turned to leasing to answer its needs, starting in a modest way by leasing equipment for just one well. Then it added other equipment to the original master lease for the remainder of its new wells. When this phase was completed, some $65,000 worth of equipment was covered by a single lease and paid for by a single monthly payment. The company's bank lines were not affected, since only the lease payments for the current 12 months are carried on the balance sheet as liabilities (with the remainder footnoted).

The next and final step this company took was to negotiate a sale-leaseback agreement involving $110,000 worth of older equipment in operation at other locations. The leasing company purchased this equipment at current market value and immediately leased it back to the company. As a result, this company today has the use of $175,000 worth of new and used equipment, it enjoys the increased income yielded by this equipment, it enjoys a favorable position insofar as production costs are concerned, and it has not impaired its short-term bank credit—all without the outlay of a dollar of liquid working capital. In fact, as a result of its sale-leaseback agreement, it has impoved its position in this respect.

Other benefits accruing to this company as a result of the lease include:

1. Expansion was made possible without dilution of ownership.
2. Equipment will be paid for out of the before-tax earnings it produces.
3. The company will deduct its full lease payments as operating expenses.

Hedge Against Inflation

Another important advantage offered to businesses by leasing is that it provides a hedge against inflation by permitting acquisition of cost-cutting equipment immediately and paying for it in depreciated dollars (thus also avoiding future increases in the cost of equipment). This explains why one of the largest packers and canners in the world last year leased the world's largest refrigerated fishing scow to add to its fleet.

For petroleum concerns, the controls on management imposed by banks and institutional lenders are often not only onerous, but may result in defeating the purpose of the loan. One operator in the southwest, for example, recently sought to finance the purchase of some $60,000 worth of equipment, which was needed to increase the output of its wells. The financing institution, however, sought to restrict expansion of the company until the new equipment was paid for. This company thereupon leased the equipment and was able to put it to work immediately to pay for itself out of earnings.

These are some of the ways equipment leasing has helped a number of petroleum companies—and many other businesses—solve problems that are becoming more and more typical in our changing economy. As with any tool, leasing fits certain situations. Where it fits can be determined only by examination of a company's liquid working capital position, its rate of profit on net working capital, its need for equipment, and the net cost of the several methods of financing available to the company. ★ ★ ★

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PROTECTIVE COATINGS

WILLIAM R. LAMBERT
United Fuel Gas Company
Charleston, West Virginia

1 Casing was cleaned thoroughly with a caustic solution to remove mill lacquer before the pipe was wire-brushed or buffed.

2 Coatings were applied by hand, either with a brush or with a spray gun. Tapes were hand applied, with or without primer.

3 Casing was run with extreme care to avoid damaging the coatings. Damaged areas were repaired by hand with coatings.

4 Casing was pulled after eighteen months with an A-frame rig. Pipe was handled with 8-in. ring and slips to reduce damage.

5 Pipe was inspected closely to determine relative protection given by the various coatings. Epoxy coats fared best in this test.

6 Damage was evaluated for each joint and overall coverage was estimated at 95%, excluding damage due to pulling casing.

ON WELL CASING

Downhole test of several types of protective coatings promise extended life of expensive casing strings

PROTECTIVE COATINGS and cathodic protection can save many of the millions of dollars spent each year by the industry in the battle against casing corrosion. Recent downhole tests of several coatings and wraps have proved the value of such preventive maintenance to protect casing strings, usually the single most expensive component of a well completion.

With few ramifications, well casings and tubing can be considered as nothing more than pipelines laid on end, and the conditions which cause a horizontal pipeline to corrode also cause casing failure. As a result, much the same approach can be used to retard casing corrosion as is taken on pipelines. A thorough knowledge of corrosion control practices on horizontal pipelines is useful in undertaking protection of well casings.

Corrosion of well casings may result from one or more of the following:

1. Galvanic action
2. Sulfate-reducing bacteria
3. Chemical action (acid in a fluid)
4. Stray currents (electrolysis)

The two major methods used to combat these causes of corrosion are protective coating of the metal and cathodic protection. A combination of the two is often the most successful method.

Rocks, and especially sediments, are conductors of electricity by virtue of the connate water which they contain, usually salt water. In fact, very few minerals conduct electricity and those that do usually comprise such a small fraction of the rock framework that their presence is inconsequential. Hence, the solid framework of reservoir rock which is made up mostly of non-conductive silicates, carbonates and sulfates, will be assumed to be non-conductive. The rock must be porous and its pores must be interconnected and occupied totally or partially by a conductive fluid such as salt water before it is conductive.

Galvanic Action

It is believed that galvanic action usually produces the most pronounced effect on well casings. Such corrosive activity is usually attributed to and amplified by the presence of salt in adjacent formations. To explain further, the voltage potential between the casing and the different formations opposite it varies from one stratum to the next. These differences in voltage result in a current flow from one section of casing to another. "Battery action" corrosion of the casing will take place where current leaves the casing on its electrical return path. Intensity of the corrosion attack will be greatest in the vicinity of abrupt changes in potential. If you can prevent this emission of electrons, you have eliminated galvanic corrosion.

Sulfate-Reducing Bacteria

Rapid corrosion of casing can occur in the presence of oxygen and acidic soils; however, serious corrosion can occur in soils or formations that are not acidic and do not contain free oxygen. This particular corrosion is microbiological and is due to the presence of microorganisms. The more important type, from the corrosion viewpoint, is the sulfate-reducing bacteria which thrive under anaerobic (little or no free oxygen) conditions. Clay soils often contain sulfates. The reactions involved are chemically quite complicated but calcium sulfide and hydrogen sulfide are formed, causing the iron in the pipe (casing) to be converted to iron sulfide.

Experience has revealed, in most instances, that the more fluid a well produces the greater is the possibility of casing corrosion and that wells along a river or stream suffer more from corrosion than those located at higher elevations.

Downhole Tests

Recently the production department of United Fuel Gas Company of Charleston, West Virginia, conducted a test program on a production well in McDowell County, West Virginia, to determine if it would be practical to coat well casings and what effect abrasion would have on the coating as the casing was run.

The experiment was set up and six different coating manufacturers provided eleven different coatings to be placed on the 8⅝-in. casing to be set at a depth of 2536 ft. The lower 905 ft of the casing (28 joints) was the test area. (See Table 1 for details.)

The casing had been painted with mill lacquer which had to be completely removed before coating could be applied. Lacquer was removed with a solution of pipe detergent "caustic soda" applied liberally to the pipe and allowed to set for 10 to 15 minutes. The pipe was then washed with clear water and the same procedure repeated until all mill lacquer was completely removed. Casing was then brushed thoroughly with a wire brush or buffed by machine, leaving a completely clean bare pipe.

Different types of coatings were applied to the casing with the assistance or under the supervision of a representative of the manufacturer to assure proper application.

Coating was applied during ideal weather conditions. Casing joints were, when required, preheated to assure that no moisture was present during the coating operation. Fig. 1-3 show some of the cleaning and coating procedures.

When drilling was completed, the 8⅝-in. casing was run. Each joint of

TABLE 1. Summary of Well Casing Coating Test.

Coating Used	Joint No.	Type	Application	Results of Test
Black mastic and glass wrap.	3, 13, 14	Cold	Brush and hand wrapped. Two coats.	Coating remained approximately 75% intact. Bond adequate.
Epoxy mastic	4, 5	Catalyzed	Brushed. Two coats.	Coating remained approximately 95% intact. Excellent bond.
Epoxy and activator	7, 8	Catalyzed	Brushed. Two coats.	Coating remained approximately 75% intact.
Wax	10, 11	Hot	Flood coated. One coat.	Coating remained approximately 5% intact. Apparently dissolved by kerosine and hydrocarbons in well.
Tape—6" wide	16		Hand applied.	Coating remained approximately 5% intact.
Wax type wrap	18	Flashed	Hand applied.	Coating remained approximately 2% intact. Apparently dissolved by kerosine and hydrocarbons in well.
Epoxy tarset	20, 21, 22	Catalyzed	Brushed. Two coats.	Coating remained approximately 95% intact. Good bond.
Joint compound	24	Cold	Brushed.	Coating damaged practically all over.
Plastic and primer	½ of 26	Cold	Sprayed.	Coating remained approximately 80% intact. Good bond.
Plastic	½ of 26	Cold	Brushed.	Coating remained approximately 90% intact. Excellent bond.

coated pipe was carefully handled and all damaged areas were patched with the corresponding coating after the joint had been screwed into place and just prior to lowering.

The well was then completed to total depth and the 8⅝-in. uncemented casing remained in place for eighteen months. The 2536 ft of casing weighed approximately 40 tons. When the casing was pulled, it took 141 tons of force to lift the casing off bottom, indicating considerable caving and friction. A 44-ft 11-in. shear pole "A" frame was used in conjunction with a heavy duty motor, wireline drums, and pulley arrangement to lift the casing. The pipe was handled with 8-in. elevators and held with 8-in. ring and slip arrangement.

The first few joints of casing had to be pulled a few feet at a time with hydraulic casing jacks. As the coated section of the casing was pulled, each joint was inspected and tested and the condition of the coating was evaluated. A summary of these evaluations is outlined in Table 1.

Physical examination of the coatings and pipe indicates that certain of these coatings were very successful in protecting the casing. Epoxy coatings appear to be the most effective and the most desirable for well casing coating at the present time. It is also well to note that the plastic type coatings held up well.

In these tests the epoxy type coatings remained on the casing and covered more than 90 percent of the pipe. This coverage would effectively seal off contact between the casing and surrounding environments and would appreciably cut down any cathodic protection required. This 90 percent coverage was determined after the casing had been lowered in and pulled out. It would be a safe assumption that half or more of the damage to the coating was done while pulling the casing. This would indicate at least 95 percent coverage on the casing as it is initially run. Fig. 4-6 show some of the casing being pulled.

Epoxy coatings are mechanically strong enough to withstand the abrasion of the hole sides while the casing is being run. These test coatings were applied in the field, and if the coating can be applied at pipe coating mills where the conditions can be more closely controlled, the bond obtained will be much better than was realized in the field. It appears from these tests that the conventional pipeline coatings such as mastics, tapes, enamels, etc., will not adapt themselves for well casing coatings.

It is our belief that current requirements for well casing protection are but a fraction of the current required for a similar amount of pipeline, due to the lack of oxygen, water, and apparent fast buildup of polarization along the casing. It is generally believed that cathodic protection of a well casing can be acquired with less than 2 milliamps per sq ft of applied current to the casing string. If the casing is completely or even partially coated the current required for cathodic protection will be greatly reduced.

Complete cathodic protection of a well casing would require that each string of casing be insulated electrically from all others with contact only at the wellhead. Each string would be coated with a non-conductive coating, and impressed current applied so current flow would be from the surrounding strata to the casing at all locations where slight voids might appear in the coating. Of course, it would be practically impossible to attain all of these requirements, but some or portions of all would tend to prolong the productive life of the casing.

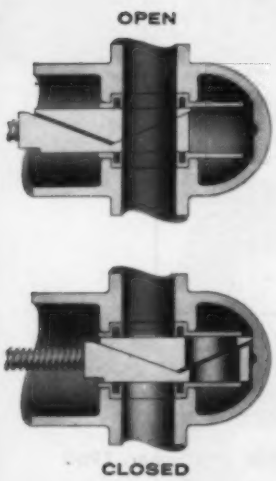
There are many types and brands of protective coatings on the market today. Some are applied hot and others applied cold. There are various sizes, shapes, and colors of wrappers, but regardless of their chemistry, their principle function is to adhere to the metal and to afford extremely high resistance to the flow of electrical currents and moisture.

In the near future, it may become common practice to apply a protective coating to all, or portions, of a well casing before it is placed in the ground. The additional expense involved in coating well casing can be justified by the importance of the facility, desired productive life of the well, and corrosion activity experienced in the area.

* * *

THE AUTHOR

William R. Lambert, corrosion engineer of the production and storage department, United Fuel Gas Company, attended West Virginia University and Temple University, receiving a BS degree from Temple in 1951. Prior to his affiliation with United Fuel in 1956, he was a corrosion engineer with Texas Eastern Transmission Corporation and pioneered in the application of cathodic protection rectifiers to their facilities. Since joining United Fuel, he has been active in the design and application of cathodic protection to production and storage well facilities. He is a member of AIME and AGS and is vice-chairman of the Kanawha Valley NACE.



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For Pumping Wells . . .

NEW METHOD PREDICTS POLISHED ROD INPUT POWER REQUIREMENTS

Close agreement with measured power is result of accurately calculating dynamic loads

J. R. NORTON, P. E.
Oklahoma State University, Stillwater, Oklahoma

POLISHED ROD input power requirements can be calculated more accurately by the use of an improved method which includes an expression for dynamic loads. Results of this new approach indicate very close agreement between the calculated and measured power. Equations developed to depict and determine dynamic loads offered the key to more accurate predictions. Until recently (see "Dynamic Loads in Sucker Rods," pg. B-33, *The Petroleum Engineer*, April, 1960), there was no accurate method to calculate the dynamic load which is an important factor in the expression for horsepower. Two other factors must be included: (1) the static load or that part which cannot be counterbalanced; and (2) the velocity at which the well is pumped.

Numerous methods are in use today to arrive at approximate power requirements for pumping oil wells. Among these are the API formula, the theoretical hydraulic horsepower, product of load and velocity multiplied by an appropriate constant and others. Proper application of any of these methods by an experienced designer will result in a satisfactory estimate of power requirements. Prior to the actual weighing of a well and dynamometer card analysis, however, considerable experience and dexterity of design were necessary to assure an economical installation.

It is generally recognized that extraneous factors influence the peak polished rod load, peak torque requirements, the effective counterbalance required and ultimately the power

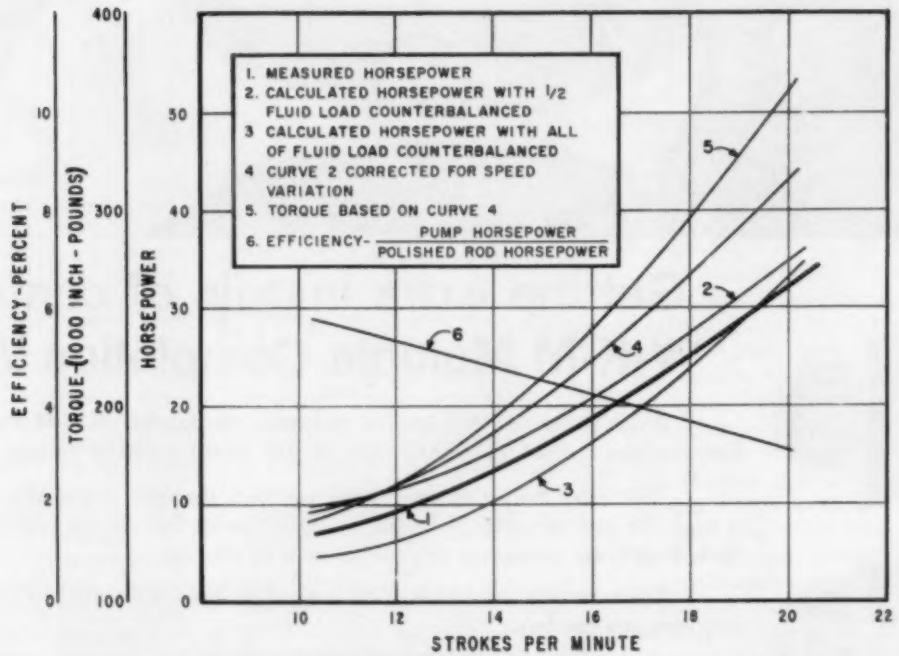

FIG. 1. Comparative curves for calculated and measured horsepower (Curves 1, 2 and 3) show very close agreement. Also indicated is relationship of torque and efficiency with pump speed.

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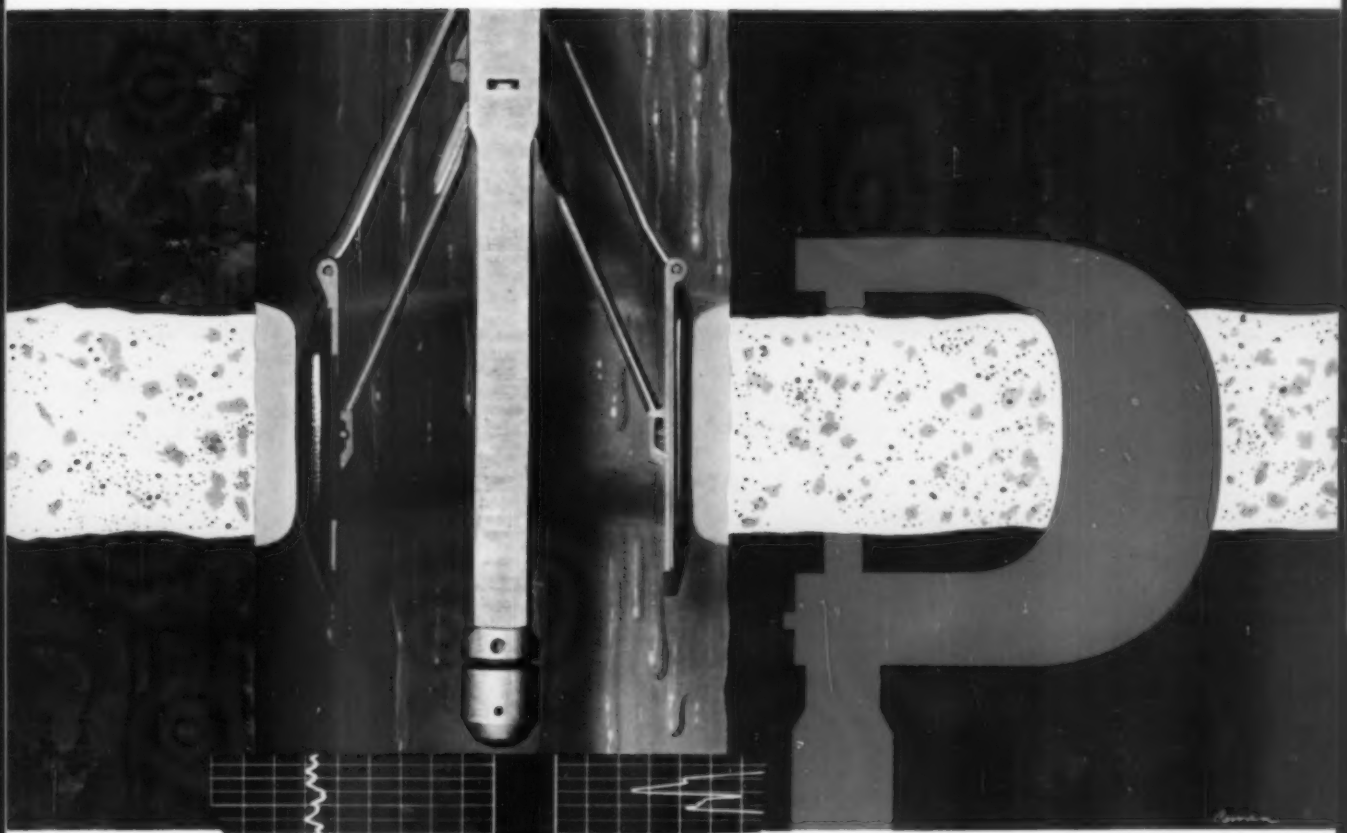

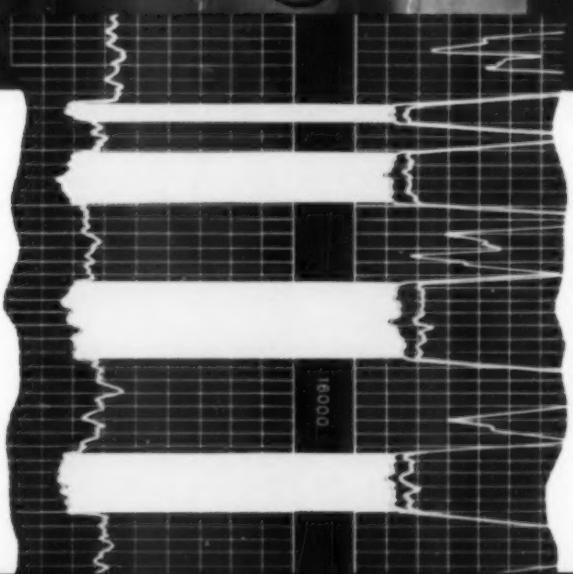

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input requirements of any well. Among these are the static weight of the rods and fluid, the amount of gas produced, and friction in the system.

Assumption and Method of Calculation

It will be assumed that the prime mover has sufficient capacity to maintain a constant angular velocity at the gearbox input. This assumption is seldom realized for economical reasons, and provisions will be made later to account for variations in speed throughout the cycle. It will be assumed further that the motion imparted to the polished rods is sinusoidal, and a means of computing power requirements when harmonics are present will be indicated. The final assumption will be that the unit is properly counterbalanced, allowing the calculation to be based upon the unbalanced loads at the polished rod.

Method of Solution

The method of derivation of the power expression will be to consider the loads and velocity to be varying in a sinusoidal manner, and from these determine the average loads and velocity over the pumping cycle.

Power is defined as the rate of doing work and is measured by foot pounds per unit of time. The product of load (in pounds) $\times$ velocity (in feet per second) is a measure of the power requirements in ft-lb per sec. Horsepower is obtained by dividing the power by 550, the power equivalent of 1 hp.

The load requiring expenditure of power is a combination of all loads which cannot be counterbalanced. These are the dynamic load, that part of the static load which cannot be balanced, and the friction in the system. For straight wells, most of the rod system friction is in the pump and fluid column. This friction load can be taken as the real part of the pump load, i.e., the first term of the pump load as given by the following formula:

$$F_p = V_p n^2 [31 v l \rho + i\omega M_f]$$

$$\text{when } V_p = \text{the pump velocity} \approx \frac{\text{Vel of polished rod}}{\text{Cos } \beta l}$$

$$\beta l = \frac{\omega l}{a} = \frac{\text{Strokes per minute x length of rod line}}{162{,}000}$$

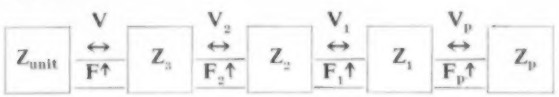
$$n = \frac{\text{Net area of pump}}{\text{Net area of tubing}}$$

v = Kinematic viscosity of fluid

l = Length of fluid column

$$M_f = \text{Mass of fluid in tubing} = \frac{W_o}{32.2}$$

The dynamic load at the polished rod for a tapered string can be determined from the following diagram and equations.



$$F_1 = F_p \text{Cos}\beta x_1 + iZ_1 V_p \text{Sin}\beta x_1$$

$$V_1 = i\frac{F_p}{Z_1}\text{Sin}\beta x_1 + V_p \text{Cos}\beta x_1$$

$$F_2 = F_1 \text{Cos}\beta x_2 + iZ_2 V_1 \text{Sin}\beta x_2$$

$$V_2 = i\frac{F_1}{Z_2}\text{Sin}\beta x_2 + V_1 \text{Cos}\beta x_2$$

$$PRL = F = F_2 \text{Cos}\beta x_3 + iZ_3 V_2 \text{Sin}\beta x_3$$

$$PRV = V = i\frac{F_2}{Z_3}\text{Sin}\beta x_3 + V_2 \text{Cos}\beta x_3$$

ABOUT THE AUTHOR

J. R. Norton is assistant director of the Office of Engineering Research and Experiment Station and Associate Professor, Engineering Research at Oklahoma State University, Stillwater, Oklahoma. A 1939 General Engineering graduate of Oklahoma State, professor Norton first joined the faculty in 1946. In 1951, he obtained his master's degree in General Engineering from the University of Texas where he spent a year's leave of absence working on his doctorate degree. His industrial experience includes plant engineer, design engineer and research engineer for W. C. Norris, Manufacturer, of Tulsa, Oklahoma. He is affiliated with NSPE, OSPE and a member of Phi Kappa Phi.

In these formulae F_p and V_p have been defined above. The impedances depend upon the rod size and are:

Rod Size, in.	½	⅜	¾	⅞	1
Z_c	372	575	820	1110	1450

The lengths x_1 - - - x_3 are the lengths of the various rod sections. The example below illustrates the application of the equation.

In the absence of specific data, the unbalanced static load can be assumed to be one-half the weight of the oil.

The pump equation giving the friction load, and the dynamic equations giving the dynamic polished rod load, and the assumed unbalanced static weight provide the necessary loads for the calculation of horsepower and torque. The power expression in general is:

Power = Load x Velocity.

This expression indicates instantaneous power which will be modified to average values over the complete pumping cycle.

Development of Polished Rod Power and Torque Requirement Expressions

Assume the well is properly counterbalanced, i.e., counter-balanced to equalize the work on the upstroke and downstroke, the power expression for peak or maximum power is:

Power = (Dynamic Load + Unbalanced Static Load + Friction Load) Velocity.

Where:
Dynamic Load = DL
Unbalanced Static Load = USL
Friction Load = FL,

then in terms of horsepower = HP,

$$HP = \frac{(DL + USL + FL)\ \text{Velocity}}{550}$$

Since the load and velocity are assumed to be sinusoidal, it is necessary that both the load and velocity be multiplied by 0.623 to obtain average values; the resulting expression is then:

$$HP = \frac{(DL + USL + FL)\ \text{Velocity x}(0.623)^2}{550}$$

Since it is more common to work with strokes per minute and length of strokes, the above expression may be rewritten as:

$$HP = \frac{(DL + USL + FL)\ NL}{26{,}980} \quad . \quad . \quad . \quad (1)$$

when N = Strokes per minute
and L = Length of stroke in feet.

The peak load occurs when the dynamic load is a maximum; therefore, the peak torque can be determined from the load used in Equation 1 above without converting it

to an average value over the cycle. This peak load multiplied by the crank arm or length of stroke divided by two gives the peak torque. An expression for the approximate peak torque becomes:

$$T = (DL + USL + FL)\frac{L}{2} \quad . \quad . \quad . \quad (2)$$

The following example will serve to illustrate the application of the load, horsepower, and torque expressions.

Sample Calculation

Sample calculation for a 6500 ft, 3-way taper rod string.
Well data:
Total depth — 6549 ft
Production — 48 bbl oil, 315 bbl water
Working fluid level — assumed 6542 ft
Tubing size — 2½ in.
Rods — 1450 ft — 1 in.
1700 ft — ⅞ in.
3392 ft — ¾ in.
Pump — 1½ in., type unknown
Pumping speed — 20 strokes per min
Length of stroke — 74 in.
Type of unit — beam
Pump depth — 6542 ft
Specific gravity of fluid — 1.154
Calculated parameters from well data:

$$\text{Mass of fluid in tubing } M_f = \frac{W_o}{32.2} = 412 \text{ slugs}$$

$$\text{Angular frequency} = \frac{SPM}{9.55} = 2.094 \text{ radians per sec}$$

$$\text{Velocity of polished rod } V = \frac{SPM \times \text{length of stroke in ft}}{19}$$

$$= 6.492 \text{ ft per sec}$$

$$\text{Transformation ratio } n = \frac{\text{net area pump}}{\text{net area tubing}} = 0.294$$

$$n^2 = 0.0864$$

$$\text{Phase constant } \beta 1 = \frac{SPM \times \text{length of rods in ft}}{162{,}000}$$

$$= 0.808 \text{ radians}$$

$$0.808 \text{ radians} = 46.275 \text{ deg}$$

$$\text{Cos } 46.275 \text{ deg} = 0.691$$

$$\text{Velocity of pump} = V_p = \frac{V}{0.691} = 9.4 \text{ ft per sec}$$

Impedance —
Lower rod section — $Z_3 = 820$ lb-sec per ft
Center rod section — $Z_2 = 1110$ lb-sec per ft
Upper rod section — $Z_1 = 1450$ lb-sec per ft

Phase constant of lower rod sections —

$$\beta 1_3 = \frac{\omega l_3}{a} = \frac{2.094 \times 3392}{16{,}800} = 0.423 \text{ radians per sec}$$

$$\text{Sin } \beta 1_3 = 0.411$$

$$\text{Cos } \beta 1_3 = 0.912$$

Phase constant for center rod section —

$$\beta 1_2 = \frac{\omega l_2}{a} = \frac{2.094 \times 1700}{16{,}800} = 0.212 \text{ radians per sec}$$

$$\text{Sin } \beta l_2 = 0.210$$

$$\text{Cos } \beta l_2 = 0.978$$

Phase constant for upper rod section —

$$\beta l_1 = \frac{\omega l_1}{a} = \frac{2.094 \times 1450}{16{,}800} = 0.176 \text{ radians per sec}$$

$$\text{Sin } \beta l_1 = 0.175$$

$$\text{Cos } \beta l_1 = 0.985$$

Lumped fluid load on pump —

$$F = V_p n^2 [31_v L\rho + i\omega M_f]$$

$$= 9.4(0.0864)[31 \times 1.2 \times 10^{-3} \times 6542 \times 1.154 + i\,2.094 \times 421]$$

$$= 228.5 + i\,700.7$$

Load at top of lower rod section —

$$F_3 = (228.5 + i\,700.7)\,0.912 + i\,9.4 \times 820 \times 0.411$$

$$= 208.4 + i\,3807$$

$$V_3 = i\frac{(228.5 + i\,700.7)}{820} \times 0.411 + 9.4 \times 0.912$$

$$= 8.22 + i\,0.115$$

Load at top of center rod section —

$$F_2 = (208.4 + i\,3807)\,0.978 + i(8.22 + i\,0.115) \times 1110 \times 0.210$$

$$= 177 + i\,5639$$

$$V_2 = i\frac{(208.4 + i\,3807)}{1110} \times 0.210 + (8.22 + i\,0.115)\,0.978$$

$$= 7.32 + i\,0.152$$

Load at polished rod —

$$PRL = F = (177 + i\,5639)\,0.985 + i(7.32 + i\,0.152)\,1450 \times 0.175$$

$$= 135.78 + i\,7412 = 7413$$

$$VPR = V = i\frac{(177 + i\,5639)}{1450}\,0.175 + (7.32 + i\,0.152)\,0.985$$

$$= 6.53 + i\,0.179$$

$$= 6.531 \text{ checks with } 6.492 \text{ original velocity}$$

Horsepower and Torque Requirements

The above dynamic load, 7413 lb, and the friction load, 228.5 lb, when added to ½ the weight of the oil, 2153 lb, are the loads to be used to calculate the horsepower and torque as follows:

$$HP = \frac{(7413 + 2153 + 229)\,20 \times 6.16}{26{,}980} = 44.6$$

and

$$T = (7413 + 2153 + 229)\,\frac{74}{2} = 362{,}415 \text{ in.-lb.}$$

In these calculations, the average speed over the cycle has been used. More accurate results may be obtained by using the actual speed at the mid-upstroke position, considered as the fundamental in the calculation of the dynamic load. If the distortion in polished rod motion due to unit geometry and slip are known, the dynamic load can be recalculated for the percent of second, third, etc., harmonics present. These loads are directly additive to the fundamental since the describing equations are linear. Closer agreement with measured results may be obtained by making these corrections. Since the dynamic load appears in the horsepower and torque expressions, they are automatically corrected for harmonics present.

A comparison based on the use of average speeds over the cycle is given in Fig. 1.

Acknowledgment

Acknowledgment is made of the sponsorship of W. C. Norris, Manufacturer, Division of Dover Corporation, Tulsa, Oklahoma, without which the work from which this paper has resulted could not have been accomplished.

Reference

1. Norton, J. R. "Dynamic Loads in Sucker Rods", *Petroleum Engineer*, April 1960.

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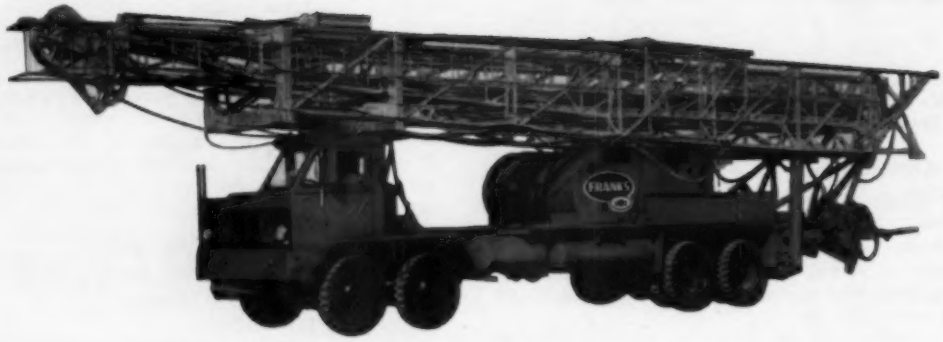

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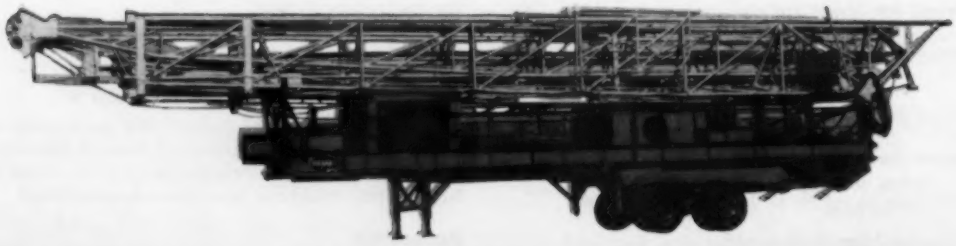

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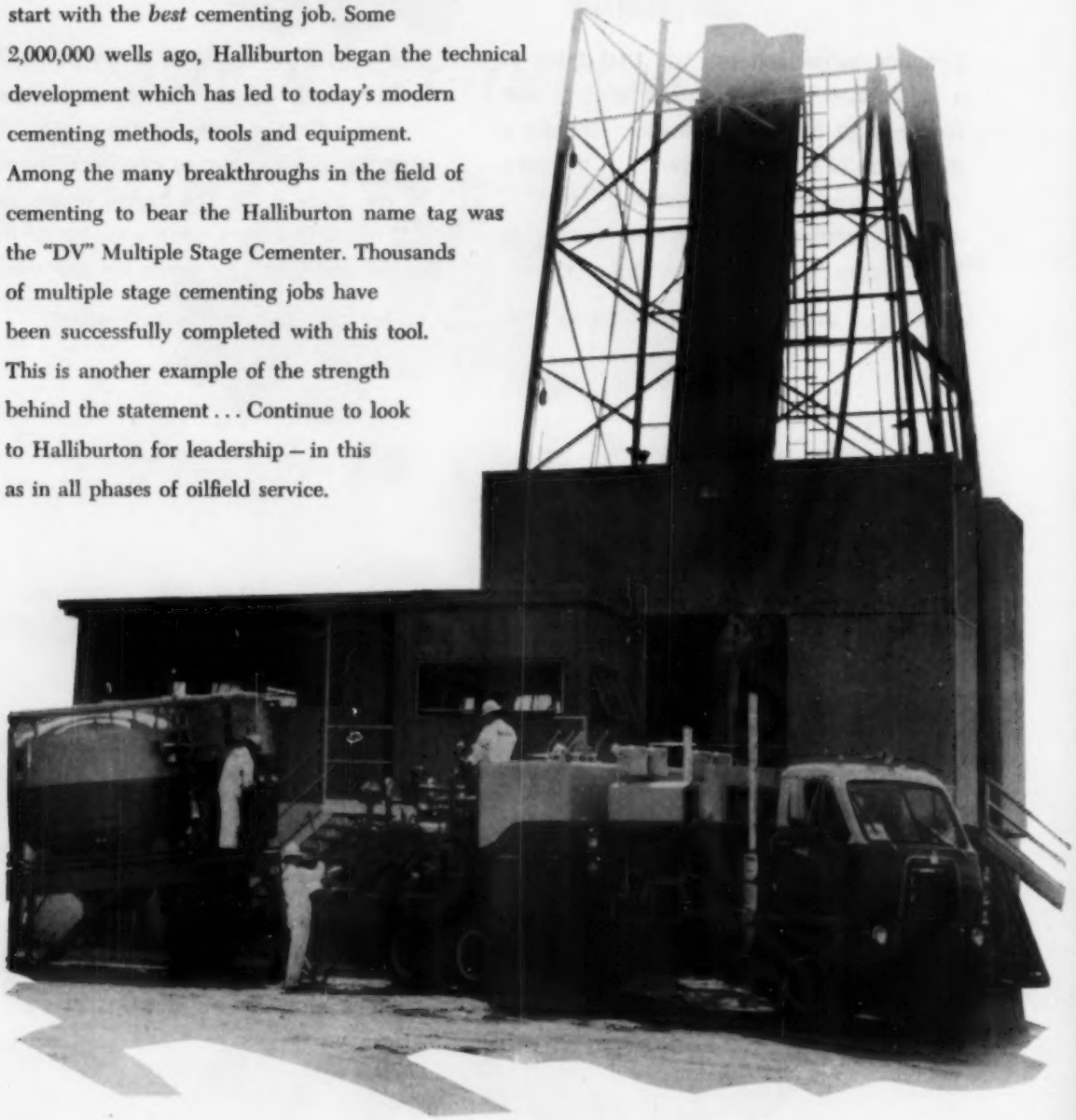

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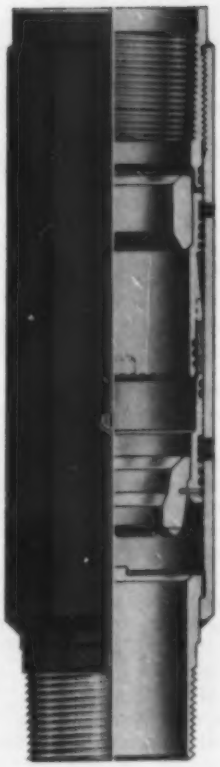

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PART 8B

Formation Testing Fundamentals

Open hole and cased hole testing methods can supply valuable production information

Cecil R. Richardson, *Halliburton Oil Well Cementing Company, Duncan, Oklahoma*

FORMATION TESTS may be divided into two classifications: those run in open hole before casing is set, and those run in cased hole to test through perforations or to test a short section of open hole below the casing seat. Formation tests may be further divided into regular tests (testing a zone below a packer) and straddle tests (testing a zone isolated between two packers).

OPEN HOLE TESTS

The open hole formation testing procedure permits testing any prospective formation without setting casing. Simplicity and economy of the testing procedure usually permits testing as many different formations as desired to prevent abandoning a potentially productive well. Information ordinarily obtained from this type of test includes samples of formation fluid, production rate of formation fluid through various sizes of bottom-hole and surface chokes, and the closed-in pressure build-up of the formation.

An open hole formation test may be run for other purposes, such as an aid in determining the best location for casing seat or perforations, determining oil-water contact, determining point of lost circulation, procurement of water samples for laboratory analysis, testing a fresh-water sand, or determining permeability damage induced in the formation adjacent to the well bore.

Several factors must be considered in preparing for a formation test in uncased hole. First, clearance between packer seat and supporting member for the packer rubber should be as small as practical to prevent excessive stress on the rubber as it supports hydrostatic pressure across the clearance gap. The packer seat should be chosen in a hard, firm foundation where hole diameter will not be oversize or irregular. The seat should provide support for the packer rubber and not be subject to appreciable deformation which would effectively increase clearance space to be spanned by the rubber.

If the packer is to be set in a reduced size core hole below the normal well bore, packer size can usually be quite close to the nominal size of the core hole. There is adequate clearance between packer and hole for most of the running in. Restricted clearance is encountered only while running the packer into the cored hole.

However, when the packer is to be set in full hole, it may be necessary to run through several thousand feet of the same size hole in which it will be seated. Therefore, condition of the hole and drilling mud are important to the successful completion of an open hole formation test.

Prior to a formation test, mud should be circulated and conditioned to remove all cuttings and debris from the well to help prevent plugging fluid passage in the testing equipment. Mud should be properly conditioned and treated to reduce gelation or solidification while mud is not being circulated. Also, viscosity and fluid loss characteristics should be adjusted to guard against sloughing or heaving of the formations or excessive fluid loss while mud is not being moved.

Double Wall Packer Test

Occasionally it may be desirable to use two packers in series. This practice is used where the condition of the packer seat is questionable, especially where vertical fractures are suspected or where the formation is susceptible to plastic deformation under load. Use of two packers doubles resistance to fluid flow around the packer and gives a better chance of obtaining a successful seal.

Straddle Packer Test

It often becomes desirable to test a formation which may be a considerable distance from the bottom of the hole. This can be done by conventional means, but several disadvantages are inherent in this procedure. The main disadvantage is that all formations below the packer are being tested and origin of any fluid recovered on the test could not be pinpointed. Also, if all the mud below the packer were produced into the drill pipe ahead of the formation fluid, a considerable hydrostatic head would be created. This back pressure on the formation may be sufficient to prevent recovery of an appreciable quantity of formation fluid. It is also obvious that much rig time will be required for making up and breaking out sections of the long anchor. Finally, possibility of sticking the long anchor due to sloughing of surrounding formations is increased, and column loading of the anchor may become excessive.

A better method for testing the uphole formation would be to use the straddle packer technique. This procedure utilizes two packers, one above and one below the formation to be tested, as illustrated in Fig. 14. Packers are separated by the proper amount of perforated anchor through which formation fluid enters the testing string. A pressure-equalizing tube is provided to maintain equal hydrostatic mud pressure above the top packer and below the lower packer. Loading of the long anchor below the lower packer is thus reduced.

Off-Bottom Test

A more recent method of testing formations located a considerable distance from the bottom of the hole eliminates the long anchor. This procedure, known as off-bottom testing, retains all features of conventional straddle packer testing. However, the long anchor is replaced by a side wall anchor assembly to engage the wall of the bore hole and provide necessary anchoring force for tool operation.

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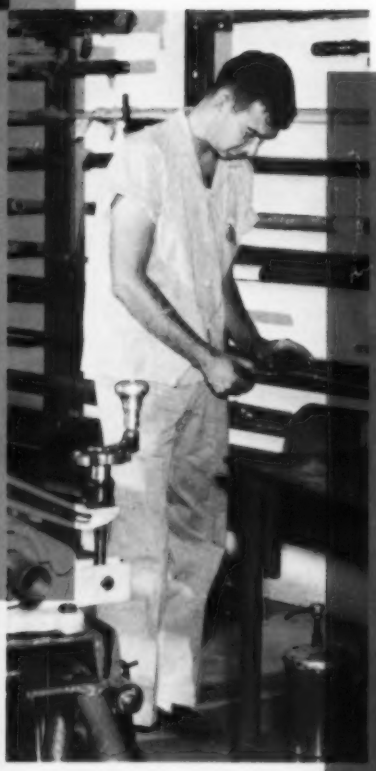

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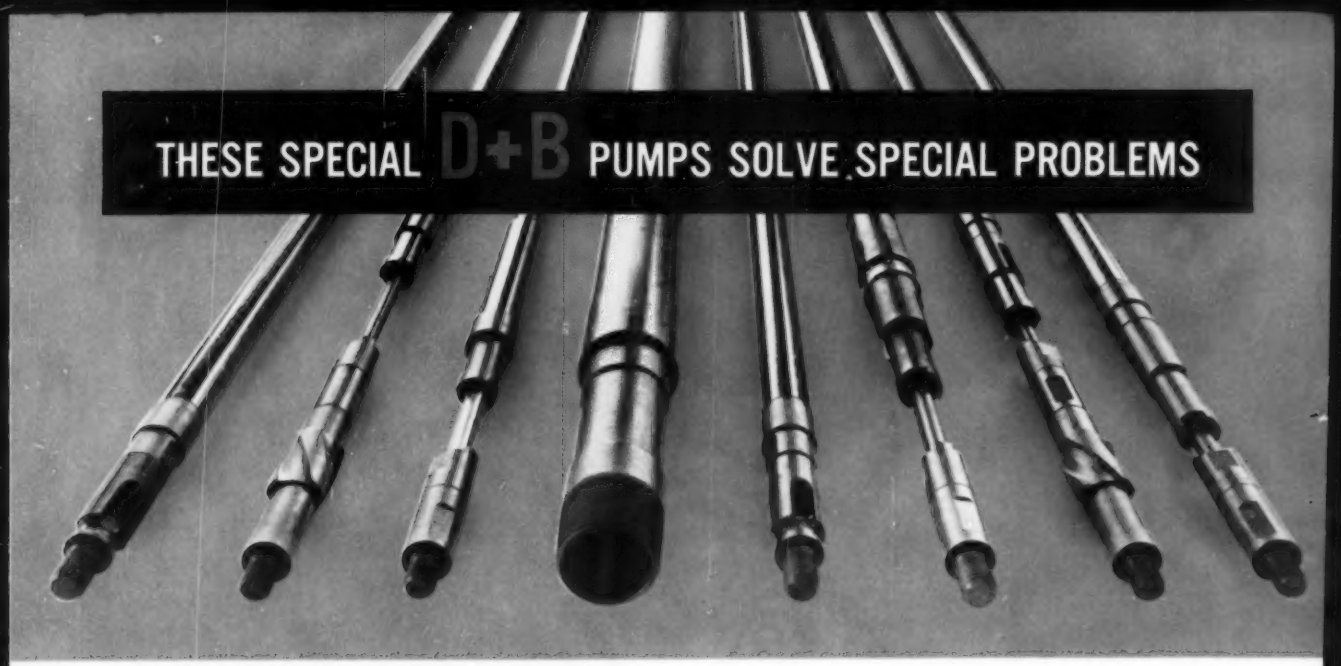

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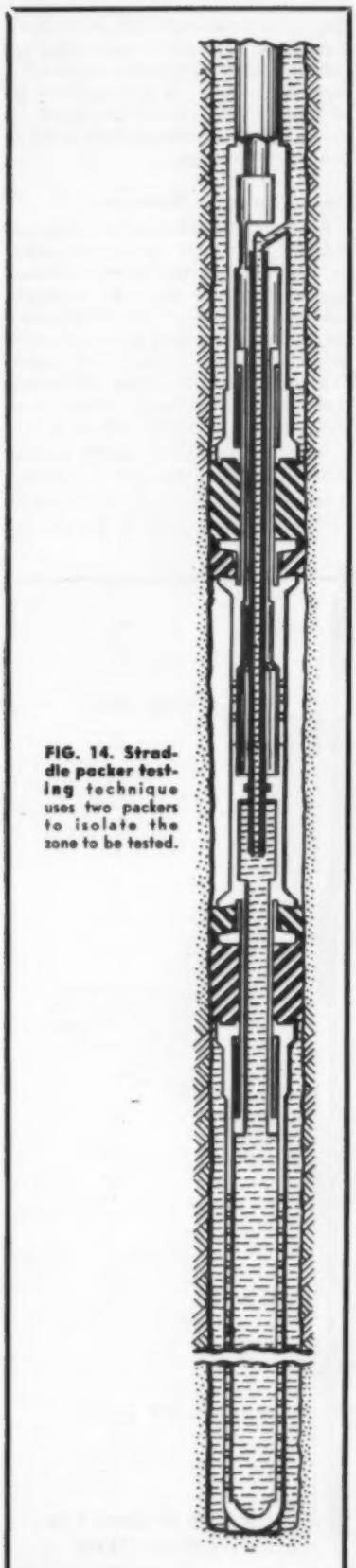

FIG. 14. Straddle packer testing technique uses two packers to isolate the zone to be tested.

CASING FORMATION TESTS

Formation testing procedure for cased holes is essentially the same as for open hole except for the means of supporting the packer. Instead of anchor pipe to the bottom, a hook wall packer is used. This packer provides support for expanding the packer element and for the hydrostatic load applied to the packer. This type of testing is used to determine productivity through perforations or from a formation below the casing. It also may be used to test for water shut-off after cementing, or for locating a hole in the casing. Water-oil or gas-oil contacts may be located by testing, squeezing, reperforating, and retesting.

When casing has been perforated in more than one section of the hole, it is necessary to run a straddle-type formation test to isolate perforations to be tested. An anchor type casing packer is used above a regular hook wall packer with perforated anchor between. A pressure equalizer similar to that used for open-hole straddle testing is used.

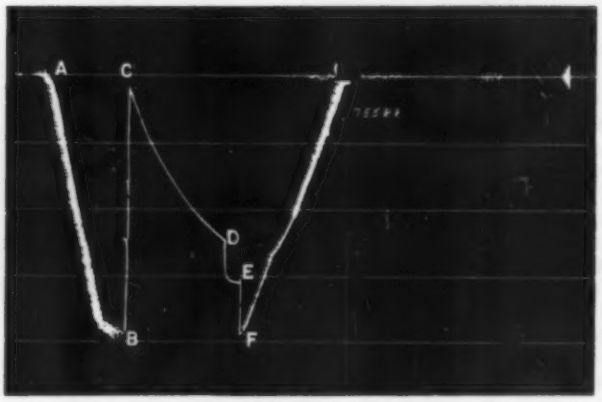

FIG. 15. Typical pressure chart taken during a formation test supplies information about downhole pressures.

FORMATION PRESSURES

Proper evaluation of a subsurface formation requires an accurate knowledge of formation pressures and the quantity and quality of fluid production. To obtain this pressure information, a pressure recording gage is incorporated in the testing string. This gage might be called the heart of the testing string since it provides a visual record of all pressure changes throughout formation testing operation. This pressure chart becomes the key which helps to unlock formation secrets and it is a valuable aid in evaluation of reservoir potential.

Pressure gage. The most commonly used pressure recording gage utilizes the bourdon tube principle for its operation. Pressure is transmitted through a rubber diaphragm to fluid contained in the bourdon tube. A stylus assembly attached to the lower end of the bourdon tube records rotational movement of the tube due to pressure changes on a specially coated metal chart. The chart is attached through a lead screw mechanism to a spring driven clock in the lower end of the gage. This clock causes the chart to move downward at a controlled rate of speed with respect to the stylus. Result is a plot of pressure vs time for the entire testing period.

The gage is installed in a running case and supported by rubber shock absorbers for protection. The case may be used as a part of the anchor, or it may be designed to be placed between packer and tester valve.

Pressure chart. A reproduction of a representative pressure chart from a formation test is shown in Fig. 15. The horizontal line across the top of the chart is the base line or the line of zero or atmospheric pressure. This line is scribed on the chart after it is placed in the gage so that it actually represents zero pressure for the particular gage. Movement downward away from the base line indicates an increase in pressure. Movement across the chart from left to right indicates passage of time.

The sequence of events which produce the chart can be followed by referring to identified points on the chart in Fig. 15. At point A, tools are ready to start in the hole and pressure reading is zero. A-B shows increasing hydrostatic mud pressure as the tools are lowered in the hole. When the testing string reaches bottom, initial hydrostatic mud pressure at the gage point is recorded at point B.

Packer is then seated and tester valve opened, isolating the gage and the

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formation below the packer from hydrostatic pressure. This pressure decrease is shown as line B-C. Point C denotes pressure at which the formation starts to produce fluid, and is called initial flow pressure.

As formation fluid is produced into the drill pipe an increasing hydrostatic pressure head is created. This pressure increase is recorded as the flowing pressure curve from C to D.

Pressure value at point D is the final flow pressure. At point D the closed-in pressure valve is closed, shutting off flow of fluid from the formation. Formation pressure then starts to increase, building toward formation static pressure and producing closed-in pressure build-up curve, D-E.

Pressure value at E is called formation closed-in pressure, and is ordinarily less than actual formation static pressure. Only when curve D-E becomes level and parallel to the base line, can point E be called formation static pressure. Rarely is this condition attained on a conventional formation test because of limited time involved. A partial build-up curve, such as D-E on this chart, can be extrapolated mathematically to determine formation static pressure.

At point E the by-pass valve is opened so that the gage again records hydrostatic mud pressure at F. Packer is then unseated and tools removed from the hole with the gage recording decreasing hydrostatic mud pressure from F to G. At G, gage has reached the surface.

Pressure value of each significant point on the chart is determined by measuring vertical distance or deflection from the base line to the point in question. A calibration curve for the individual gage is then used to convert this linear measurement to pressure in psi. The calibration curve corrects for well temperature.

Blanked-off gage. It is desirable to use at least two pressure recording gages on a formation test and to have one gage blanked off. Proper location of the two gages in the testing string is shown schematically in Fig. 16 which also illustrates the manner in which a gage is blanked off.

Upper gage, designated as the flow stream gage, is located above the packer and receives its pressure during the test directly from formation fluid entering the perforated anchor and flowing into drill pipe. Lower gage is located below perforations in the anchor and is isolated or blanked off from fluid passing through the testing string. This gage receives its pressure directly from the annular space between anchor and wall of the drilled hole. Ordinarily these two gages will be subjected to identical pressures, neglecting slight hydrostatic difference due to their different vertical location.

The reason for blanking off one gage is to help detect plugging of anchor perforations. At the instant packer is seated and tester valve is opened there is a very sudden release of pressure from the area below the packer, and consequently a sudden rush of fluid through the anchor perforations. If foreign particles are present in mud, it is possible that perforations may become plugged so solidly that no fluid can pass through. If this occurs, no pressure will be transmitted into the testing string and flow stream gage may record no pressure, even though pressure is present at the face of the formation.

The blanked-off gage should continue to record actual pressure present at the face of the formation, even when plugging of perforations occurs, since fluid in motion is required to cause plugging, and there is no fluid movement past the blanked-off gage. A discrepancy in pressure charts from the two gages, as shown in Fig. 16, indicates that perforations may have plugged.

Dual Closed-In Pressure

As previously mentioned, it is seldom possible to obtain actual formation static pressure directly by conventional formation testing methods. Recognition of the value of this information has led to development of a specialized technique aimed at recording static formation pressure during the testing operation. This technique is known as dual closed-in pressure method. It differs from conventional testing in that closed-in pressure build-up is recorded before the flowing period of the test as well as final pressure build-up at the end

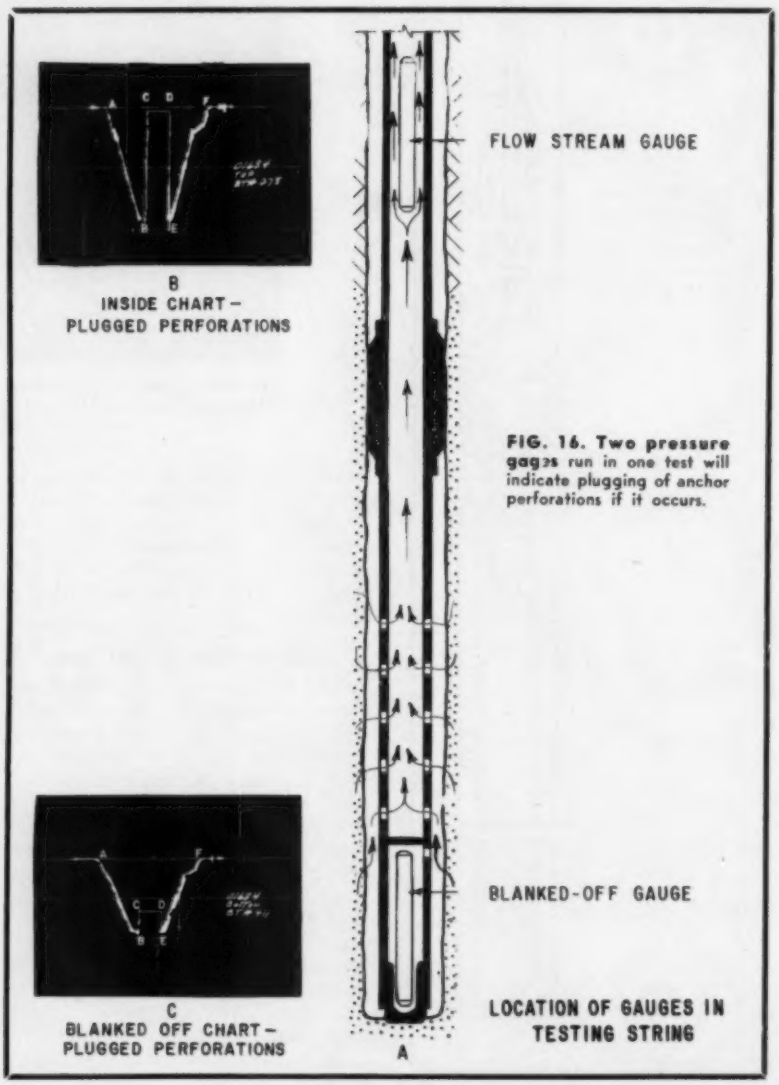

FIG. 16. Two pressure gages run in one test will indicate plugging of anchor perforations if it occurs.

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of the flowing period. Value of this procedure is that formation pressure can reach its static or maximum value in a much shorter time interval before near-static conditions have been disturbed by the flowing period.

Obtaining a dual closed-in pressure requires that the formation be relieved of hydrostatic mud pressure and then be immediately closed in with a minimum of disturbance of the formation fluid. This can be accomplished as illustrated in Fig. 17 by installing an auxiliary valve in the testing string above the tester valve.

The empty volume between the two closed valves is used as an expansion chamber to dissipate hydrostatic pressure of mud below the packer when the tester valve is opened. As expansion of mud fills the void space, with the auxiliary valve still closed, formation is automatically closed in after being relieved of hydrostatic mud pressure.

Opening of the tester valve and release of hydrostatic pressure is recorded as line A-B on pressure charts in Fig. 17. Initial closed-in pressure build-up is recorded from B to C. At point C the auxiliary valve is opened allowing the formation to produce into empty drill pipe. Remaining operations are the same as on a conventional test.

Initial closed-in pressure build-up attained a value of about 3200 psi at point C and had leveled off, indicating that static pressure had been reached in the 30 minutes during which the formation was closed in. The final build-up curve, E-F, during an equal length of time, attained a value of only about 2600 psi, which does not even closely approach static pressure. This serves to illustrate value of the dual closed-in pressure procedure.

An improved method for obtaining the initial build-up curve is now in general use. It utilizes a specially designed valve which can be closed immediately after releasing hydrostatic pressure from below the packer directly into the drill pipe.

Use of Information

Formation pressure build-up curves may be used to estimate formation permeability and permeability damage which exists near the bore hole. A knowledge of the severity of this "skin effect" or damage is important in determining desirability of well stimulation.

If during the formation test sufficient formation fluid is produced to fill the pipe and flow out at the surface, actual production rate can be measured directly. It is also possible to estimate open flow potential of a gas sand based on rate of flow and flowing pressure data obtained on tests through one or more choke sizes.

On a non-flowing test, which is predominant in exploratory testing in open hole, since drill pipe is only partially filled with formation fluid, an index of the producing ability of the formation can be obtained from test results. Accurate measurement of fluid recovered, time duration of the flow period of the test, and flowing and closed-in pressures can be utilized in calculating this productivity index, which is defined as the rate of formation fluid production in barrels per day per psi pressure drop at the face of the formation. This factor is used to estimate commercial producing ability of the formation.

A careful analysis of fluid recovered is of course important in evaluating results of the test. Specific gravity of oil recovered can be measured and gas-oil ratio can usually be estimated. A salinity analysis of any water recovered is helpful in determining whether it is

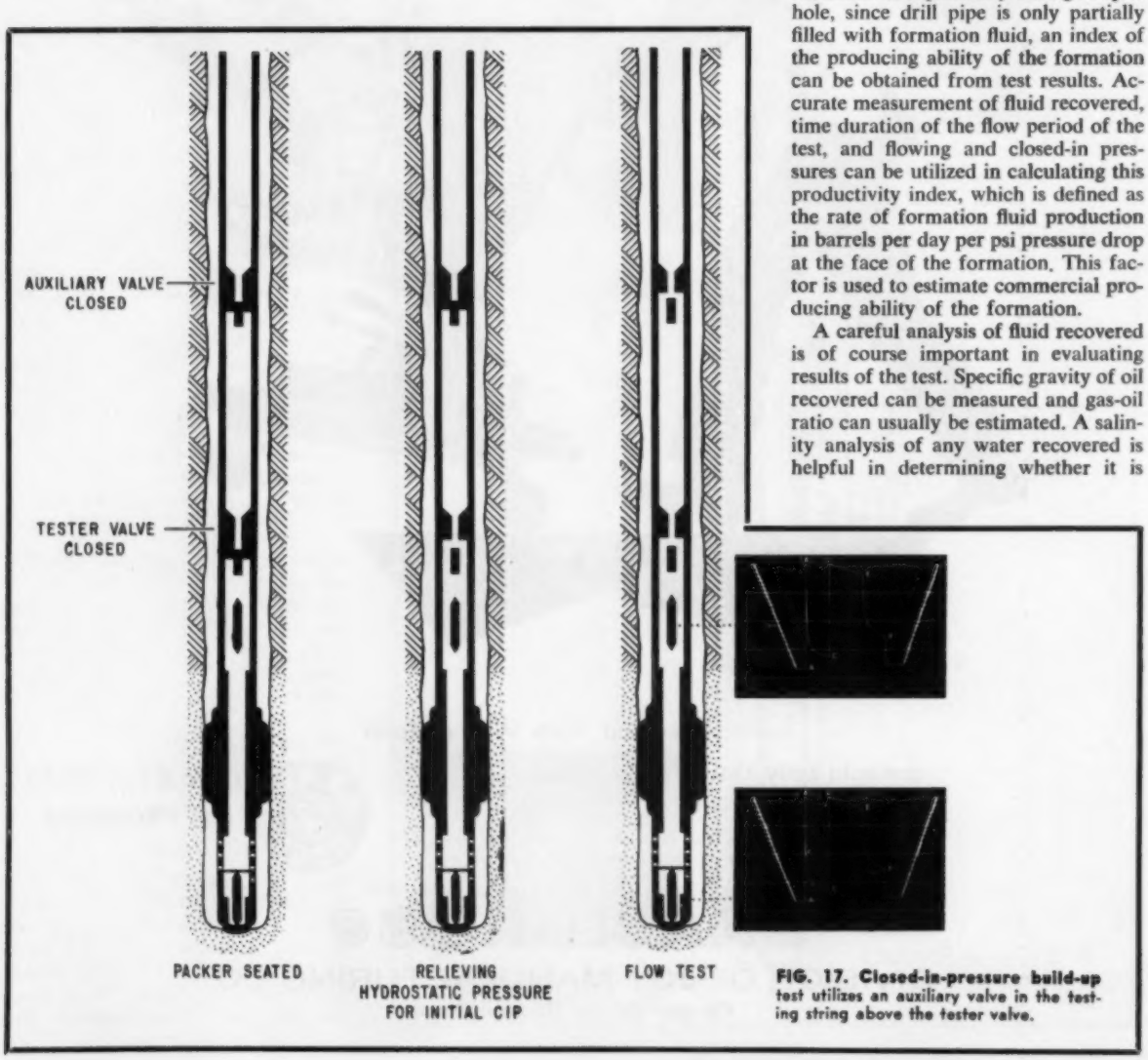

FIG. 17. Closed-in-pressure build-up test utilizes an auxiliary valve in the testing string above the tester valve.

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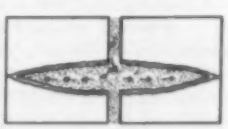

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formation water or mud filtrate that has been lost to the formation during drilling, or both.

If the volume of mud recovered is appreciably greater than the volume of mud that should have been contained in the bore hole below the packer it may be indicative of a fractured or vugular formation. These results might show need for a mud clean-out treatment to remove the mud from the porous spaces of the formation.

RECENTLY DEVELOPED TECHNIQUES

Continuous Retrievable Sampler

The continuous retrievable sampler technique allows formation tests to be made while drilling without removing drill pipe from the hole. This is accomplished by incorporating a packer as a part of the drilling string and recovering a sample of formation fluid in a reservoir which is retrievable by a wire line.

When it is desired to sample a formation that has just been penetrated by the bit, the sampler assembly is dropped into the drill pipe. When the sampler has reached its seat, pump pressure is applied to inflate the packer, causing it to seal against the wall of the hole. A valve in the sampler assembly opens to admit formation fluid from below the packer into the sampler reservoir.

At the end of the test period, pump pressure is released, allowing sampler valve to close and packer to deflate. The sampler assembly is then retrieved with a wire line and the fluid recovered is analyzed. A pressure recording gage is contained in the sampler assembly to record formation pressures.

Retrievable Valve Tester

The retrievable valve tester has been developed for use in formation testing inside casing. Used with a full-opening packer, it provides a means for making a formation test and subsequently performing treating, squeezing, perforating, or further testing operations without removing tubing from the well.

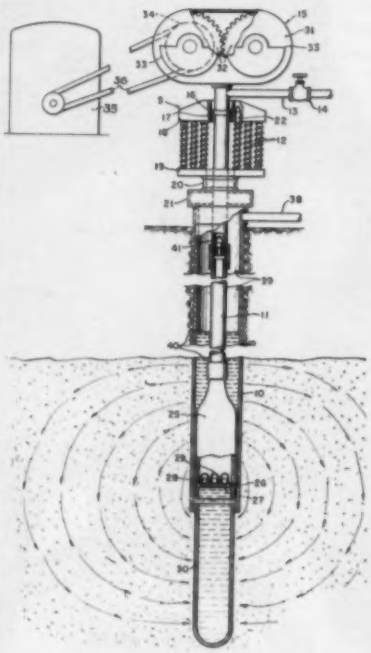
The system utilizes a retrievable valve, which contains the valve mechanism for making the test and also incorporates a pressure recording gage. A full-opening retainer case is installed in the tubing string above the packer to provide a seat for the retrievable valve.

A conventional test is made, including a closed-in pressure recording. At completion of the test, valve assembly with pressure recording gage attached is removed from the tubing by reverse circulating or with a wire line. Packer and tubing remain in the hole to perform any subsequent operations that may be necessary. ★ ★ ★

WHAT'S NEW IN PATENTS

Brief notes on selected oil field patents recently granted

PAUL H. JOHNSON • JAMES R. HEAD
Patent Attorneys, Tulsa, Oklahoma

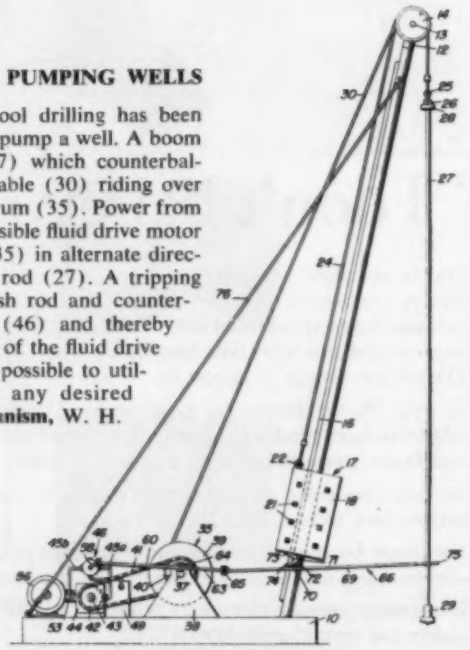


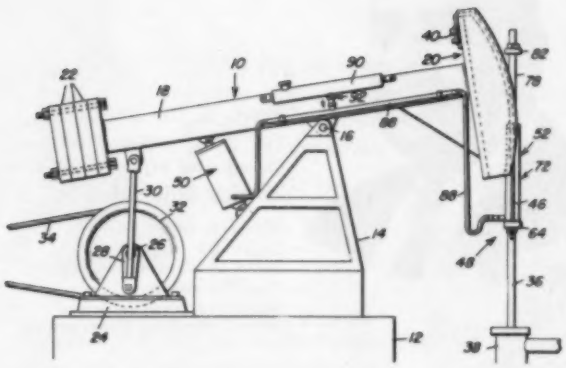
SONIC STIMULATION PROPOSED FOR AILING WELLS

INCLUDED in this invention is a method to increase the effectiveness of chemically treating oil-producing formations. Chemical is introduced as a solution into the well bore. A sonic wave is propagated into the solution and surrounding formations by means of eccentric rotating weights (33). A valving mechanism (27 and 28) located in the bore hole adjacent to the producing formation creates a pumping action by sonic vibration of the tubing and thereby sets up negative wave pulses. These pulses return the treating solution to the well bore for removal from the well. **Sonic Method of Injecting and Circulating Chemicals in Oil Well Formations,** A. G. Bodine, Patent No. 2,918,126.

CABLE TOOL IDEA FOR PUMPING WELLS

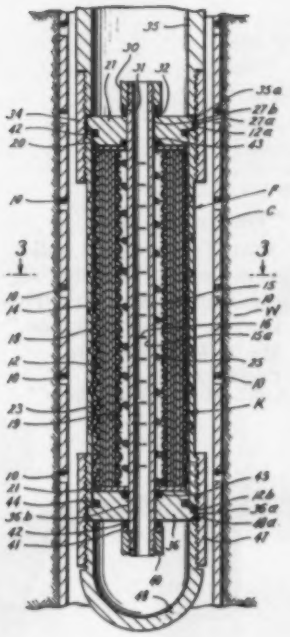
BASIC IDEA used in cable tool drilling has been applied to reciprocating rods to pump a well. A boom supports a slideable weight (17) which counterbalances the sucker rod load. A cable (30) riding over pulley (14) extends to a cable drum (35). Power from motor (56) is applied to a reversible fluid drive motor (44) that rotates cable drum (35) in alternate directions to raise and lower polish rod (27). A tripping device associated with the polish rod and counterweight serve to actuate valve (46) and thereby reverse the direction of rotation of the fluid drive motor. This principle makes it possible to utilize pump strokes of almost any desired length. **Pump Actuating Mechanism,** W. H. Allen, Patent No. 2,926,000.





ATTACHMENT INCREASES WALKING BEAM STROKE

THE ADDITION of a hydraulic attachment and controls to a conventional pumping unit provides a means to increase the stroke length without increasing length of the walking beam or crank arm. The hydraulic pump is attached between walking beam and sampson post. Two hydraulic motors, each consisting of a cylinder and piston, are placed between the bridle of the horse head and the polish rod clamp. A flexible hose connects the hydraulic pump so that on each upstroke of the pumping unit, hydraulic fluid is forced from the hydraulic pump into the hydraulic motors. Action of the hydraulic motors further raises the polish rod over the length of the stroke of the horse head, thereby increasing the stroke of the pumping unit. **Stroke Increasing Attachment for Walking Beam,** Ben E. Muschalek, Jr., Patent No. 2,877,652.

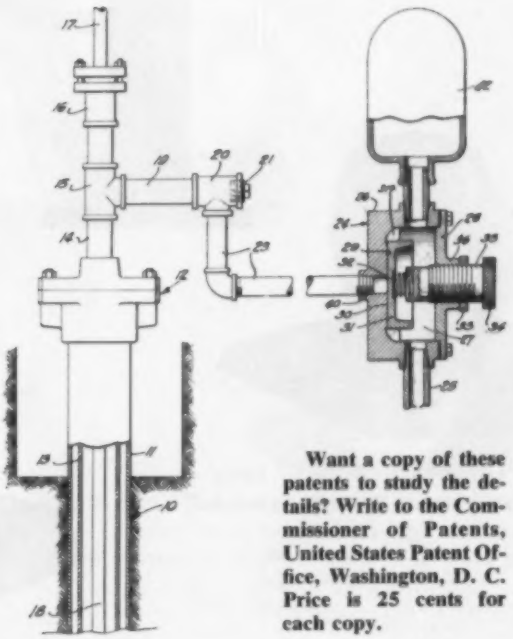


GLASS FABRIC FILTERS WELL FLUIDS

A FILTER is located on the bottom of the tubing string to filter sand from produced fluids. The casing body of the filter assembly is perforated to permit fluid to enter the filter media (23). A slotted inner tube of the filter conducts fluid into the tubing string and on to the surface. The filter media is packed off top and bottom and held in place by spring tension. The filter material consists of glass cloth fabric layers which are replaceable. A bull plug (48) seals off the open end of the tubing element which extends through the filter assembly. **Well Filters,** Frank F. Bashara, Patent No. 2,877,852.

SOUND WAVES TO REMOVE PARAFFIN

OBJECT of this invention is to clean the inside of tubing and sucker rods of a well which has a tendency to accumulate paraffin during production. Sound waves are generated to resonate in the tubing with amplitudes sufficient to induce cavitation. Effectiveness of sound waves increase when the well is under elevated producing pressures. A valving mechanism is shown on the outlet of a producing well. This mechanism includes a spring (32) that closes a valve (31) against the pressure of produced fluid. When pressure in the tubing (18) and line (23) builds up sufficiently to overcome the spring pressure, valve (31) opens, fluid pressure in line (23) is reduced, and the valve is again closed by spring (32). In this manner, sonic waves are generated which travel through the column of fluid and down into the well to free the inside of the tubing and sucker rods of paraffin accumulations. **Method of Cleaning Out Well Pump Tubing and the Like,** A. G. Bodine, Jr., Patent No. 2,918,127.



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Why a resume of oil field patents? We live in a world of ideas, and most of the tools now used in the oil fields were first described in patents granted to inventors by the United States Patent Office. While much has been written in the past on patents, there's a new awakening to ideas in the oil industry today, and we believe a brief summary of a few selected oil field patents would further keep our readers informed on what to expect in the future. If this feautre is of interest to you, please write and tell us. If you don't like it, tell us that, too. Send a card or letter to: J. E. Kastrop, Editorial Director, The Petroleum Engineer, P. O. Box 1589, Dallas 21, Texas.

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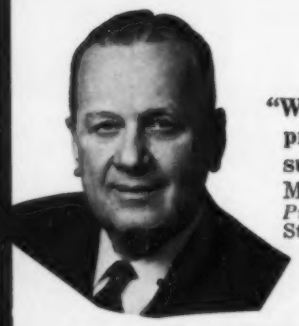

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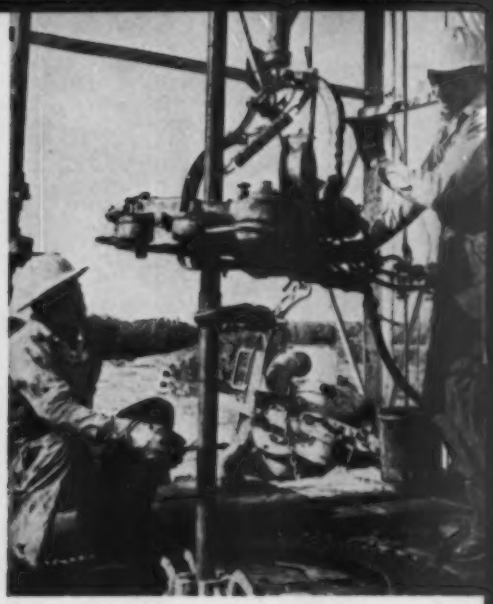

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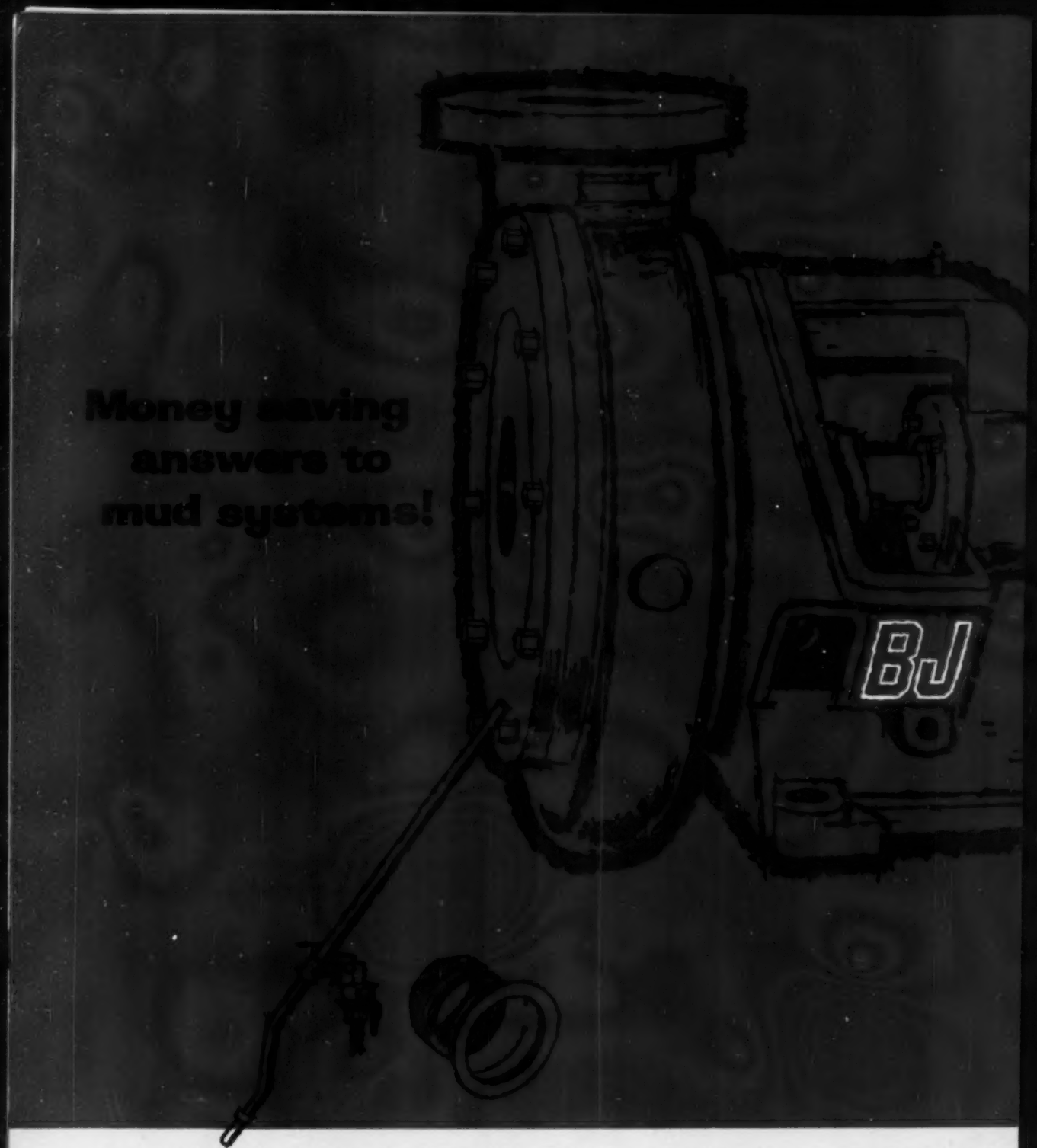

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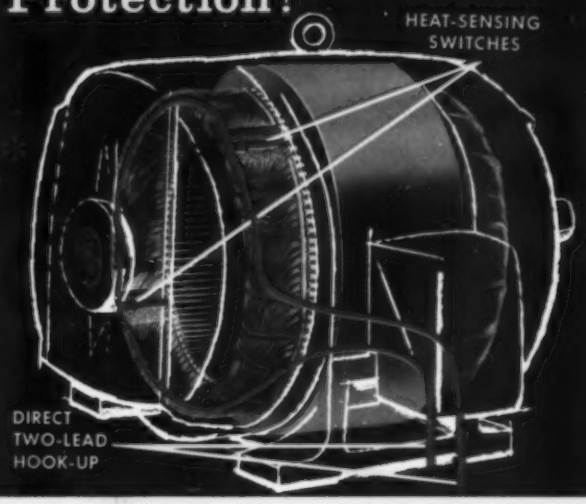

General Electric offers a *totally new* type of protection on *all* Tri-Clad '55' motors 7½-125 hp!

Exclusive THERMO-TECTOR system has heat-sensing switches buried in stator windings. Switches shut off motor *only* when stalls, overloads or other conditions threaten heat damage to motor windings.

Unique THERMO-TECTOR system "anticipation" feature varies motor shut-off point according to rate of winding heat rise. This flexibility allows *maximum motor output* under all conditions.

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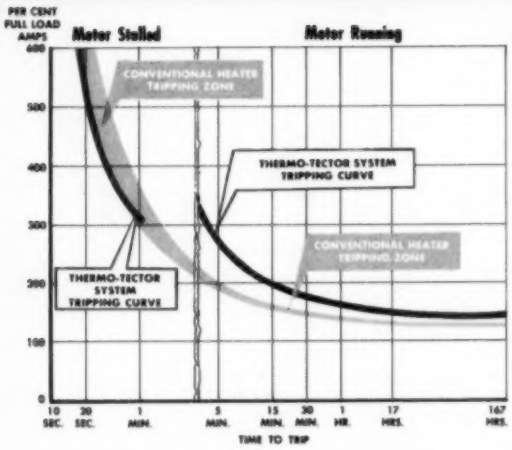
New THERMO-TECTOR System Allows Maximum Motor Output With No Danger of Burnout



Performance curves show THERMO-TECTOR system's fast response to rapid heat rise (left) and greater motor output allowed under normal run conditions (right).

No wasteful "safety margin" of overprotection is necessary on Tri-Clad '55' oil-well pumping motors equipped with new THERMO-TECTOR system.

This exclusive new inherent protection system has an *anticipation feature* that varies motor shut-off point according to *rate* of winding heat rise. This means you can take full advantage of the special high torque and slip characteristics of the Type KOF motor with no danger of burnout from stalls.

Early or late tripping is eliminated, since THERMO-TECTOR system shuts off motor *only* when stalls, lack of ventilation or other conditions threaten *heat damage* to motor windings.

Tri-Clad '55' motors with THERMO-TECTOR system end need for buying "too much motor." For details, see your G-E Apparatus Sales Engineer or Authorized Distributor, or write for Bulletins GEA-7092 and GEA-6546, Section 874-01, Schenectady 5, N. Y.

SMALL AC MOTOR & GENERATOR DEPARTMENT

GENERAL ELECTRIC

R. F. LOLLAR
Maracaibo Oil Exploration Corporation
Ottawa, Kansas

ANY ESCAPE FROM WATERFLOOD PRORATION?

Waterflood restriction may become next step in halting oversupply . . . two methods presented would prorate production without damaging reservoirs and still give reasonable return on investment

IF PRORATION of primary production is accepted as sensible, then why not oil production from waterfloods? In most instances, waterflooding has been practiced in older and primarily depleted areas and its relationship of productivity as contrasted with the whole is not yet consequential.

But imagine a sudden change of policy on the part of many primary operators by converting to waterflood, thus avoiding the allowable restrictions to which they are now subjected. That potential is no idle threat to the industry and probably is a very real possibility in the minds of state governing bodies.

It would appear that proration is sensible for all, or the economics of the industry will become worsened beyond endurance. In prorating a waterflood, however, there are factors not comparable to primary proration. Consideration, for instance, could be given to either prorationing of rate of water injection or the extent of allowable development.

Timing in either case should be considered as it relates to economics of the venture. Proration, in any instance, becomes proration of dollars, not oil, and if it can be accomplished without serious injury to the waterflooder and provide benefit to the industry, it becomes a safe and economically sane approach to the problem.

Decision Facing Commissioners

Industry personnel have divided themselves on the principles involved in prorating a waterflood, adding to the confusion of commissioners trying to find an equitable solution to the problem. Some producers like to believe that state agencies are not concerned with economics, but if those agencies were stripped of their powers to prorate, price of crude would fall within the month to a point where return of capital to most producers would be impossible.

Commissioners, probably recognizing the future possibility of additional ills that waterflooding could result in, seek an intelligent answer to this very alarming problem. Waterflooders will have to yield a lot and their opponents must yield a little in order to find some workable solution. If no such solution is found, then future proration of waterflood oil by standards set by the state will probably be adopted as the state alone sees the problem.

State agents are well aware of the economic injury that proration could do to a waterflood, yet those economics do not differ greatly from the condition of primary restrictions. When and if proration of waterfloods becomes imminent, they will make every attempt to work out an equitable solution, but perhaps now is the time for those so affected to offer plans and ideas if it is possible to devise them.

Accidental Proration Injurious

Accidental prorations in our past experience and association have always been most injurious. One of the first waterfloods to be operated west of the Mississippi, Alluwe, Oklahoma, suffered a mechanical failure in the late 1930's at a time when production was at 600 bbl per day and still advancing to an unknown peak. After a plant

shut-down of only a few weeks, production declined to 100 bbl per day and was restored to only 250 bbl per day after plant operation was reinstated.

In Pennsylvania, a proration order by a pipeline company caused a producer to reduce its injection rate. Result was the same — about a 50% loss in daily production and a substantial loss of ultimate reserves.

A property in New York followed the same pattern, and there are a host of Kansas properties which can probably offer good evidence that proration is most harmful under certain circumstances and conditions. Thus, good conservation practices cannot be satisfied when continual and constant pumping of production wells and removal of fluids are interrupted.

A Sound Theory

By the mere act of introducing water to energize a reservoir and thus force oil from one position to another, it obviously follows that: to inject reasonable amounts of water at safe pressures, to remove all fluids from production wells to provide for maximum pressure gradients, and to operate the project 24 hr a day throughout the life of the project, would be the ultimate of efficiency. Any circumstance which violates the principle, no matter to what degree, reduces the efficiency of the end result and will certainly not contribute to conservation interests.

Moreover, managements of present floods entered into their projects of invested capital with full knowledge and belief that they could operate without oil restriction, and to change that policy now after they have committed themselves financially would violate the standards of equity.

Conversely, primary producers have entered into their projects with full knowledge that an allowable not only exists but is subject to change. Consequently, any revision in his proration orders, up or down, has already been considered in his original risk.

Prorating Produced Oil

Proration of oil from a production well would require pumping the well less frequently and fluids in the well would rise, maybe even to the surface. Hydrostatic head thus created could cause water to stand at the sand face and be injected into a low-pressure stratum. On that basis, an oil well would automatically become, in part, a water injection well and there is reasonable doubt that a pay zone so invaded by water would ever again respond to oil productivity. Obviously, proration of oil is no solution to the problem: the greatest risk to a waterflood is to interrupt the continual pumping of wells to remove all fluids, especially water.

Prorating Injected Water

State regulatory bodies, to date, have not generally concerned themselves with proration of water injection. When and if that policy is adopted, it may become a little more evident as to that which is a waterflood and that which is not a waterflood and may end the abuses of disposal wells being called otherwise.

Recovered oil from a waterflood is, of course, a factor of many relative circumstances where quantity of introduced water is the most significant. It is possible that before applying for a waterflood permit, an operator should be able to project the peak production he anticipates from a given amount of water introduced.

This would allow the commission, through proration of water injection rate, to retain control of production from waterflooding, which is not now possible. Operator, knowing maximum allowable oil production, enters into his commitment with a calculated risk which would not be pursued further unless economics justified the development.

Commission could increase water introduction, but should not decrease it. Under no conditions would interruptions occur at production wells.

A disadvantage of this method is that the more permeable sand would flood out more rapidly than other zones. Thus, the principles of equal water distribution in pay layers, resulting from selective shooting, would not be served.

Those principles, on most projects, are not being served anyway, however, with the advent of fracturing and the reluctance of operators to observe those principles even where the practice of shooting still exists.

Should the allowable rate of water injection be less than that established from higher but still safe pressures, the ultimate oil to be recovered may still be the same. But the reservoir must be produced longer and profit on the venture, because of interest and operating expense, will be less. Those conditions are also true of any restricted primary well.

Such a method of proration would not necessarily be acceptable to waterflood operators. It is rather intended only as a suggestion of a method that has more favorable characteristics than limiting crude production from the producer.

Limiting Investment To Prorate Development

This method would prorate not only oil to be produced, but size and timing of investment to be made. It may have more acceptance, especially from the financial viewpoint, than any other plan, although it also has hazards.

It is almost impossible to imagine just how such a plan could work unless commissioners would know at the beginning of a specified period the number of new floods contemplated, the possible extent of intended primary development during the period, and the allowable that such new production could stand within conservation limits.

From this information, it may be possible to allocate future waterflood development during the period, although the equitable distribution of this allocation would be difficult to determine.

Mechanics of such a plan might provide that upon applying for a waterflood permit the applicant would have to submit maps of the area and to indicate possible formation thickness, core analysis, and proposed spacings. In general, he should supply all information that is then known, as well as possible results of future oil production that may be anticipated.

In permit later granted by the commission, it could be stipulated that the operator in his development could not exceed, on a cumulative basis, a specified percentage per annum of total development ultimately contemplated.

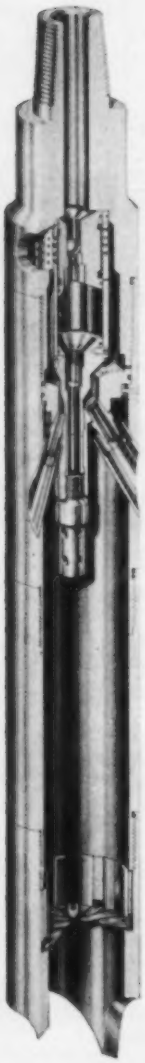
Formulae could possibly be devised using number of wells, pay thickness, injection rates, and other data that may encourage operators to observe open and full disclosures throughout in preparation of applications.

It is possible that permits could even be issued on a basis of restricted development vs restricted production, whichever is greater, to discourage operators from projecting a lower figure of future oil productivity than they believe will actually exist later.

Normally, under a plan of development proration, the producer could operate on his allowed development

ABOUT THE AUTHOR

R. F. Lollar is general manager of the Eastern Kansas division of Maracaibo Oil Exploration Corporation, with whom he has been employed since 1954. After attending Purdue University, he joined Penn Valley Crude Oil Corporation in 1935, and in 1937 was named vice president and member of the board of directors of the company. In 1940, he became president of the company and member of the board, in which capacity he served until joining Brundred Oil Corporation in 1952 as general manager. In 1954, the Eastern Kansas properties of Brundred were purchased by Maracaibo Oil Exploration Corporation and he became general manager of these properties for Maracaibo. He has been employed in waterflooding in some capacity since 1935, in fields of Pennsylvania, Oklahoma, New York, and Eastern Kansas.



Cutaway of Wilson Jet-Powered Junk Retriever. Complete specifications and operations available in booklet form.

Great Western Drilling Co. Rig #44 on deep test for The Atlantic Refining Co., Kelly #1, Pecos County, West Texas.

(Left to right) J. D. Mosley, toolpusher, Great Western Drilling Co., Rig #44; P. E. Todd, Wilson Supply Fishing Tool Division, Odessa, Texas; Bob Foster, driller, Great Western Drilling Co., Rig #44.

Wilson "Jet-Powered" Junk Retriever Cleans 18,121 ft. West Texas Hole

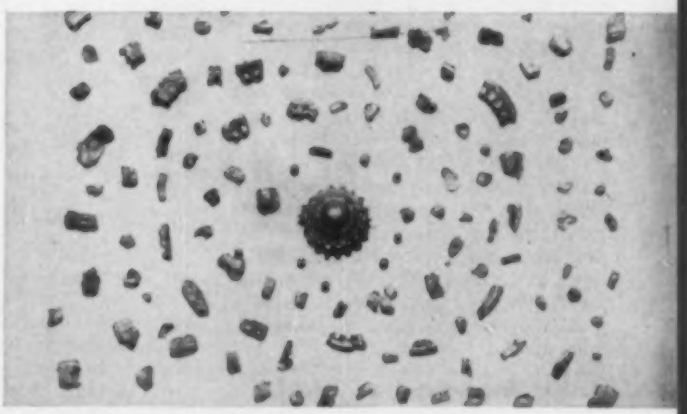
Only on bottom for 4½ hours recovering bearings and 4⅛" rock bit cone

A 3⅝" Wilson "Jet-Powered" Junk Retriever on 2⅜" Internal Flush Drill Pipe was run to 18,121 feet to recover junk and rock bit cone in a deep West Texas drilling test. The Wilson Junk Retriever was on bottom for 4½ hours and successfully cleaned the hole.

Two 700 hp pumps at 2000# produced only 110 gallons of fluid per minute through the 1" I.D. (2⅜" O.D.) pipe on which the Wilson Junk Retriever was run. Even with this small volume of fluid the tool's built-in ejector pump functioned properly and forced the 4⅛" bit cone and other miscellaneous junk into the tool's sleeve.

This is just one of many successful fishing jobs recorded by the Wilson "Jet-Powered" Junk Retriever. The tool is simple to operate, effective in performance and is available for use by all recognized fishing tool companies. In this instance the tool was run by M & B Fishing Tool Co. of Odessa.

The next time you have a junk-removal problem, call WILSON. You'll save time and money . . . and you'll get the **right** men with the **right** tools to handle your fishing job safely — quickly.



Photograph taken at rig location of the junk removed by the Wilson Junk Retriever at 18,121 ft.

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completely free of further proration laws, without fear or worry that these might interfere with his rate of return of capital, and the state would have no concern regarding over-production from waterflooding.

Improving Conditions

It is clearly recognized that ultimate profit from a waterflood venture is best served, taxes not considered, by a rapid development and depletion so that operational expense can be minimized. and that under these proration laws final profit realized would be less. However, if final figures compare favorably with restricted primary production, then waterflooders would hardly have any justification for complaint.

There may be reasons why such a plan would not work beneficially to all interests, but at least this plan also appears superior to waterflood proration as it now stands. Perhaps a combination of prorating by water injection rate and development would offer an even better approach.

Under these suggested alternatives, the state commission would have a better knowledge of what operators plan to produce about a year ahead. They would then certainly be in a much better position to make intelligent decisions for protection of both parties interests, and they need not be further concerned and confused by the division in ranks of what is good and what is not good for waterfloods.

Usually, a company operating within its own means and with its own capital is automatically prorated because of limited cash resources. Recently, however, managements have begun to spread out their risks and use new capital and co-mingling partnerships. As a result, waterflood projects are accentuated and will continue in that direction under the conditions of changing times for so long as invested capital in the oil business looks more favorable to an outsider than other mediums of investment.

Actual Waterflood Results

The assumption is made that oil production and recovery are mainly dependent in proportion to the rate and quantity of water introduced. Curves in Fig. 1 present facts about an 80-acre Maracaibo Oil Exploration development.

Reservoir was drilled as fast as time would permit. Water was entered at maximum safe pressures, and all oil wells were pumped without interruption for entire flood life until the present time.

In short, every factor of this development and operation was that which is generally considered the best of conditions, leaving nothing to be desired.

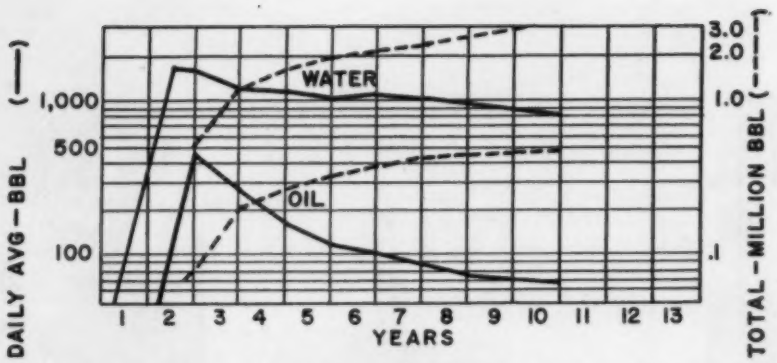


FIG. 1. Operating history of an actual 80-acre waterflood project shows a total recovery of 480,000 bbl of oil in approximately ten years.

These curves indicate a recovery of 480,000 bbl during a period of ten years. As shown, a return of invested capital was effected in about 2.5 years, as shown in Table 1, without considering acquisition, administration, and interest expense or taxes.

Development cost, using some old wells, amounted to $118,000. Capital expenditures were $103,000 and operating expenses up-to-date equal $323,000, an average of $4000 per month, or $0.76 per bbl of recovered oil.

According to factual information established by the curves, the fill-up of reservoir in terms of "percentage of total pore volume" as related to ratio of "current water-in to oil-out" existing at that time is as follows:

Fill-up Percent Volume	Approx. Ratio Water vs oil	Actual Ratio in %
0.2	8 to 1	12.2
0.4	4 to 1	26.3
0.8	5 to 1	18.2
1.0	6 to 1	15.3
1.5	12 to 1	9.1
1.8	12 to 1	8.8

It is believed that, under truly ideal conditions, had less water been injected daily into the reservoir of this property, it is quite likely that ratios established above would still follow a similar pattern.

Restricted Injection Plan

Projected curves indicating that oil recovery would remain about the same, even with lower injected water rates, are shown in Fig. 2.

In these curves it is assumed that, upon application to the state commission, highest oil allowable placed on this future waterflood would be set at 350 bbl per day, and under these conditions a regulation order would allow injection of 1000 bbl per day of water and no more.

The amount of water could be spread out over the entire property, as shown, or limited to only a part of the development. In addition, it is assumed that the total of 2.1 pore volumes will be necessary to flood out the property to a point comparable to that which actually exists.

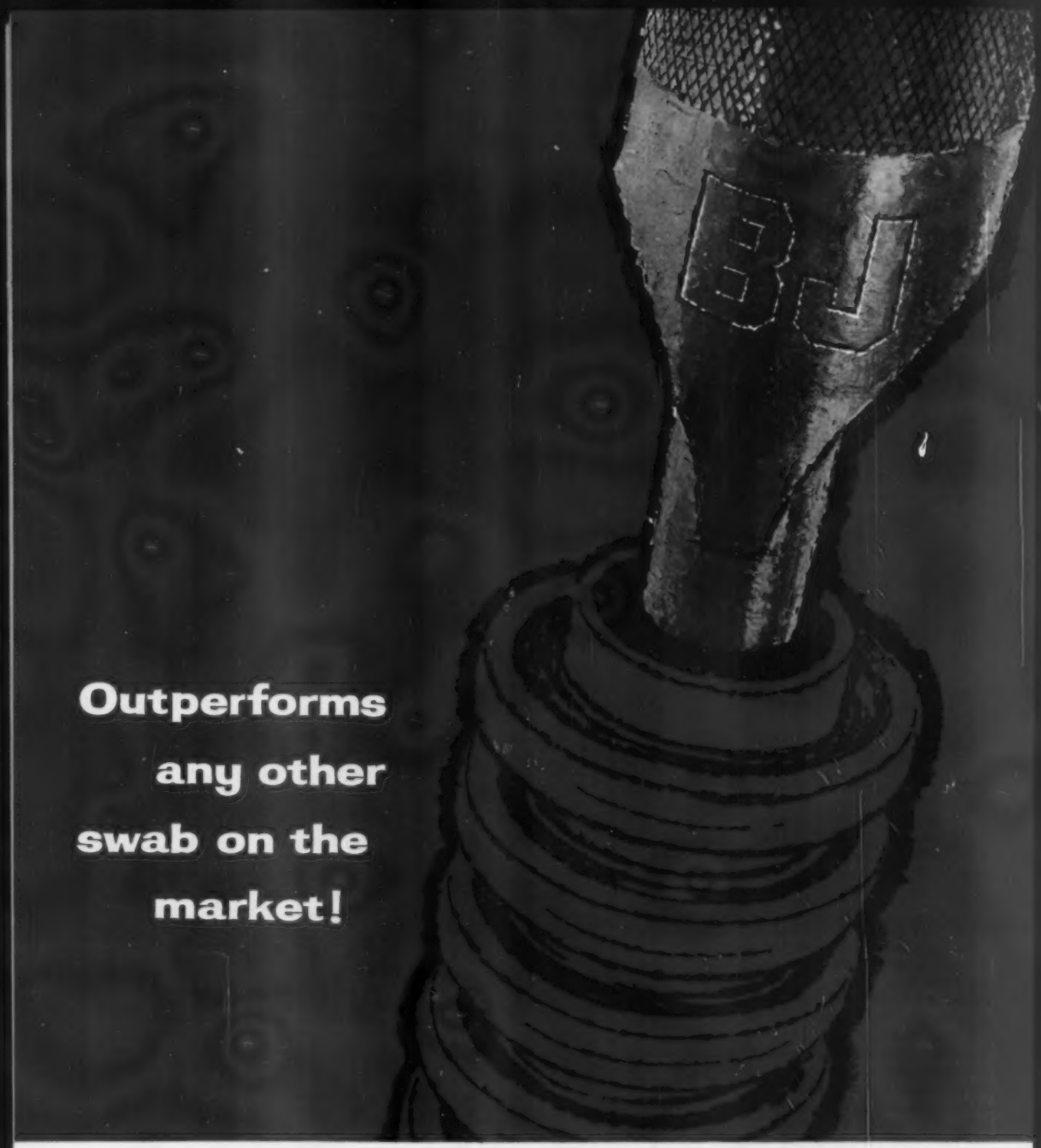
Under the conditions of such a plan of proration, it may be possible to increase water intake allowables after it has been established definitely that oil production did not increase to original expectations. This would make it possible to hold peak productivity longer.

Even should the plan be adopted, it is still clearly evident that operating time of such a prorated project is of longer duration than will actually exist.

TABLE 1 from Exhibit 1. Actual Economic Experience.
(figures expressed in thousands)

Years	Income	Capital expenditures	Operation expenses	Cash flow	Cumulative cash flow	Discounted value
1	$ 12	$ 90	$ 17	$(95)	$(95)	$(86)
2	153	128	50	(25)	(120)	(21)
3	268	...	44	224	104	168
4	163	...	47	116	220	79
5	119	5	46	68	288	42
6	100	...	57	43	331	24
7	78	(2)	50	30	361	15
8	63	...	50	13	374	6
9	56	...	50	6	380	3
10	50	(50)	50	50	430	19
—	$1062	$171	$461	$430		$249

(Parentheses denote RED figures.)



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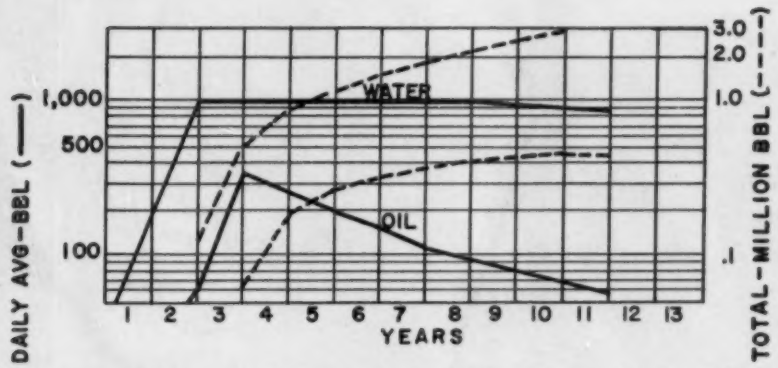

FIG. 2. Theoretical operation of same property shown in Fig. 1 shows results of proration of injected water to 1000 bbl per day. Total recovery is same, but life of project is eleven years.

Presented curve of production to economic limits indicates one full year of additional time spent. This alone amounts to at least $48,000 more operating expense than shown in Fig. 1, and results in about $0.10 per recovered bbl additional expense. Other expenses remain about the same except for administration and office. In actual practice, probably two full years additional time will be needed. Table 2 shows economics of the plan.

Using such a method of proration, net cash return would not have been reduced materially unless two or more years of additional operation time were necessary. If additional time does become necessary, it affects the economic outlook, but being subject to discount figures for these later years, the seriousness is thus minimized.

Naturally, further water intake rate restrictions would extend operating limits, which if carried out four additional years, would not support original waterflood economic considerations.

Restricted Development Plan

Assume in Fig. 3 that the state allowed as development proration, a three-year span between beginning injection on two 40-acre reservoirs, water injection and all produced oil would be free from restrictions.

Actually, two separate floods would exist and the first one might be abandoned three years earlier than the second. Operating expense would be identical to other curves except for the first three-year period, during which it would be reduced about $1000 per month. Table 3 gives economics of proration by limiting development.

Original capital expenditures and development expense would only be half that indicated previously. In such a proration, for practical purposes, assume oil production, water injection, pore space, and other factors to be equally divided.

Fig. 3 indicates 480,000 bbl of oil being recovered over a period of eleven years, but it does not show an earlier abandonment of acreage developed first.

Return of Investment

For all practical purposes all curves indicate approximately the same oil recovery, and while this may serve conservation interests satisfactorily, there are many factors of prime importance to the operator. The most important single factor to the operator is the question of the timing of his return of investment and subsequent profit.

Only random schemes of proration have been shown here. If, however, the plans of proration were accentuated so as to provide for a longer operation, it is clearly obvious that the return of money to the operator, in being subjected to discounting over that longer period, would completely discourage any development at all, thus serving no interests whatsoever.

Waterflood Economics

In an attempt to evaluate the importance to the operator of waterflooding proration, we must consider only dollars-in and dollars-out and the timing. Nothing else is material.

Investments in oil, just as in any other business, become a problem of evaluating future dollars or appraising that which one is willing to pay now for dollars he will receive later. By using an applied discount rate of future interest that one seeks to recover over the years involved, related to the net dollars that will be received over that period of time, the present worth of a property is established. Thus at a property abandonment, if the dollars-in and dollars-out and the involved timing all materialize as originally planned, the operator has recovered a rate of return to the extent that was earlier anticipated.

Tables are submitted to illustrate

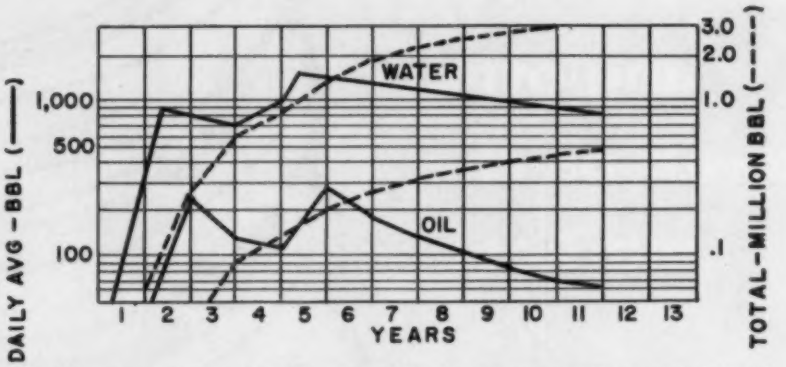

FIG. 3. Two-phase operation of the 80-acre waterflood as two separate 40-acre projects would result from development proration. One phase would follow the other by three years.

TABLE 2 from Exhibit 2. Projected Economics Under Prorationing of Rate of Water Injection.
(figures expressed in thousands)

Years	Income	Capital expenditures	Operation expenses	Cash flow	Cumulative cash flow	Discounted value
1	$None	$ 90	$ 17	$(107)	$(107)	$ (97)
2	20	128	48	(156)	(263)	(129)
3	120	...	48	72	(191)	54
4	256	...	48	208	17	142
5	185	...	48	137	154	85
6	136	...	48	88	242	50
7	105	...	48	57	299	29
8	85	...	48	37	336	17
9	69	...	48	21	357	9
10	58	...	48	10	367	4
11	51	(50)	48	53	420	18
—	$1085	$168	$497	$420	—	$182

(Parentheses denote RED figures.)

Here is the world's first quintuple string producing well

It was drilled to 7,981 feet by a National 1625 Diesel Electric Rig. It is producing through a total of 34,029 feet of tubing, of which 24,005 feet is 2⅜" O.D. Spang Extreme Line Tubing (plastic coated)

AND HAS A . . .

Unique quintuple wellhead

From the bottom of the tubing spool to the top flow line plugs, this National Supply wellhead is 10 feet 1 inch high and weighs approximately 9,100 lbs. The well tested a total of 492 million cf/d of gas on open flow from six zones, five of which are producing simultaneously.

designed by National Supply!

Forty miles off the Louisiana coast is the world's first quintuple string producing well. Its history-making wellhead is a product of National Supply. Ten feet, one inch high and weighing over 9,000 lbs., the wellhead was designed, assembled and tested at National Supply's Houston Plant.

Sinclair Oil and Gas Company and partners completed this 7,981-ft. well in six zones, five of which are producing simultaneously. All five tubing strings were run simultaneously. From the uppermost flow line plugs to the bottom of the hole, the first quintuple well represents a triumph in engineering, equipment and operating techniques.

A wellhead "first" isn't new for National Supply. National Supply designed the first fully independently run dual tubing string assembly, installed in 1954 on a West Texas well. Other examples of National wellhead leadership are:

First fully flanged independent multiple string tree with sealed-in-steel seals.

First multiple string tubing hanger and wrap-around pack-off for multiple tubing string manipulation with Christmas tree control.

First to separate the slip load due to casing weight and the packing load resulting from formation pressure.

National wellhead features are unexcelled, as proved by these 10 major reasons for using National multiple string heads:

1. NATIONAL Multiple String Heads are available in four basic designs to suit any requirement, can handle applications from low pressure pumping to high pressure gas or oil wells.
2. Provide maximum flexibility and safety.
3. Afford *complete independence* for each producing zone.
4. Handle completion cycle in manner similar to single completion . . . using same design of equipment, but reduced in size to permit handling two or more tubing strings.
5. The Laurent seal* — "sealed-in-steel" — is used for higher pressures.
6. Hangers are self locating.
7. Simplicity characteristic of conventional equipment is found in the multiple string design.
8. Maximum interchangeability of multiple tubing string hangers in the same wellhead body.
9. Plastics or liquids are not required to effect the seals.
10. National Supply's many years of engineering experience stand behind the design of the multiple string equipment.

Talk with the National Supply representative in your area before you buy another wellhead. He has more information you can profitably use.

*Patent No. 2,687,229

Quintuple wellhead was designed, assembled and tested in National Supply's Houston Plant. Tubing spool, tubing hanger, quintuple port flow tee, crown member and flow fittings were made by National Supply.

A 16 mm color sound film on the world's first quintuple completion well is available for group showings. If your group would like to see this film, please write to: Sales Manager, Production Equipment, The National Supply Company, Pittsburgh 22, Pennsylvania.

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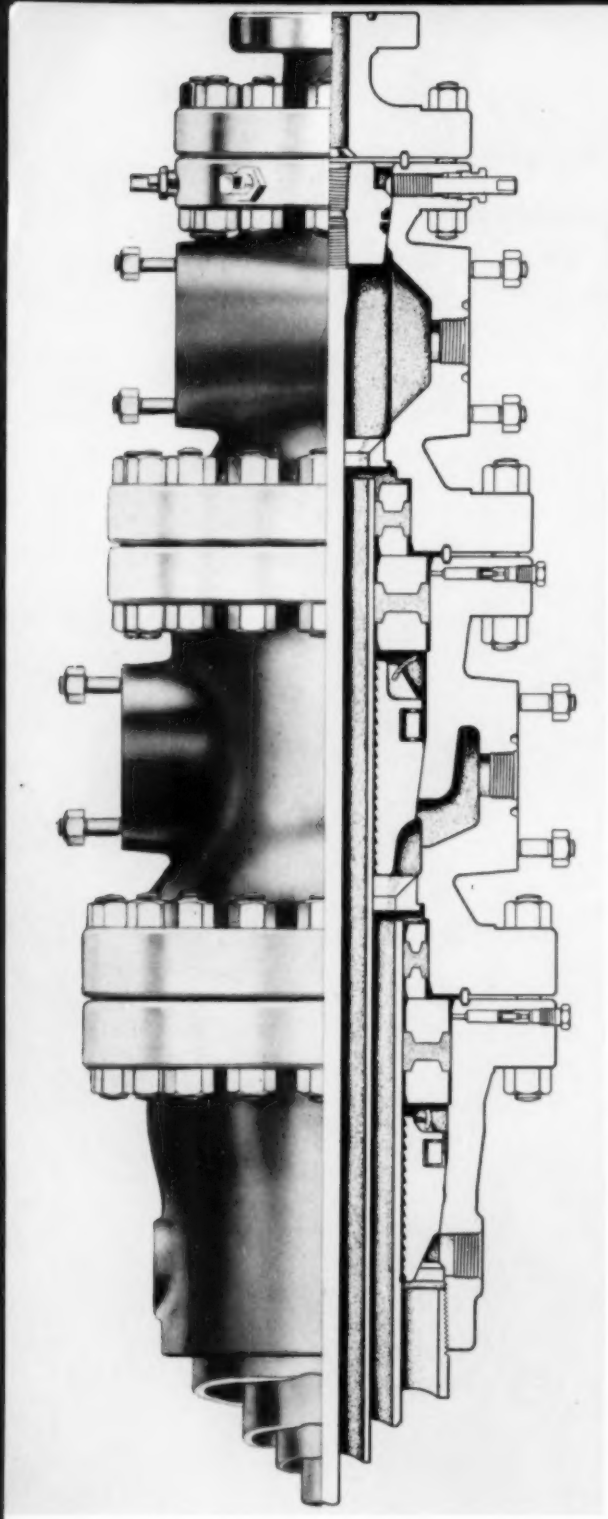
Steel's Symbol of strength, long life, and economy



Triple record set by NATIONAL Type B Wellhead Equipment!

Here's the latest big performance record on National Type B Wellhead Equipment —

1. Was selected to suspend the *longest* string of casing ever run in a well
2. Selected for two of the last three record depth wells
3. **It has never contributed to a casing failure**

This 3-way record proves the value of advanced design and engineering which gives National Wellhead Equipment the highest safety factor for every application. One outstanding example of this advanced design is the counterbored casing flange which permits separation of pressure and slip loads, and is usable with all standard blowout preventers (see drawing).

All National Wellhead bodies and components are rigorously tested at levels above those recommended by API—another assurance of dependability and safety in service. National Type B Wellhead Equipment is manufactured in a complete range of sizes, with casing heads, casing spools and tubing spools available for working pressures up to 15,000 p.s.i. Ask the National Supply representative in your area to tell you about the other advantages you gain—including the advisory services of National Supply's wellhead equipment specialists.

◀ This drawing of Type B Wellhead Equipment illustrates the pressure-packed principle employed to separate pressure loads from slip loads.

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BELOW 20,000 FEET

Had this well been dry, it would merely be another statistic. Yet, it was completed as a producer.

To prove production possibilities on this deep Louisiana well, five Drill Stem Tests were run below the 20,000 ft. mark. In each instance, the packers were set below 20,000 feet, making these the deepest Drill Stem Tests ever recorded.

Testing conditions were most severe. Throughout each test, bottom hole temperature was 426°, mud weight ranged from 18.2 to 18.4, with a viscosity varying from 50 to 60. During the five deep tests, Johnston equipment encountered and recorded formation pressures as high as 19,365 psi and hydrostatic mud pressures up to 22,045 psi.

Packers and other equipment have previously been run and set below this depth; however, none in a Drill Stem Testing operation, nor under the conditions encountered in this well.

No misruns or equipment failures occurred. All equipment was retrieved intact. On two tests, equipment remained in the hole over twenty hours. Tests were performed in 7 inch—35 lb. casing through a 3/8 inch bottom hole choke. All were successful.

Drilling a well below 20,000 feet is a significant accomplishment, especially with the subsurface conditions peculiar to the Gulf Coast. The five Johnston Tests performed at this depth are also significant. They are testimony to the fact that Johnston can conduct Drill Stem Testing operations at extreme depths where high bottom-hole temperatures and extreme high pressures are encountered.

The drilling, testing and completion of this well is a prime example of the value of experience and planning, and proves the advisability of gathering all available information and data for evaluation prior to completing any well.

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Final Hyd. Mud 20,061 psi
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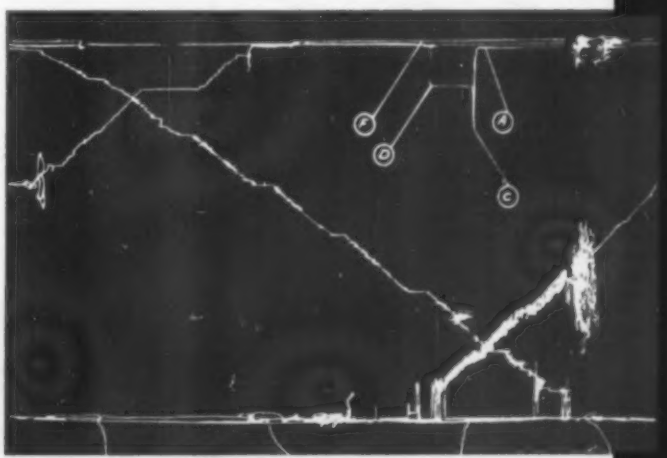

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TABLE 3 from Exhibit 3. Projected Economics Under Prorationing of Development. (figures expressed in thousands)

Years	Income	Capital expenditures	Operation expenses	Cash flow	Cumulative cash flow	Discounted values
1	$ 6	$110	$ 17	$(121)	$(121)	$(110)
2	72	...	36	36	(85)	30
3	136	...	36	100	15	75
4	120	110	48	(38)	(23)	(26)
5	136	...	48	88	65	55
6	185	...	48	137	202	77
7	128	...	48	80	282	41
8	95	...	48	47	329	22
9	76	...	48	28	357	12
10	61	...	48	13	370	5
11	52	(50)	48	54	424	19
	$1067	$170	$473	$424		$200

(Parentheses denote RED figures.)

such procedure as related to known and hypothetical situations. For practical purposes, a 10 percent discount rate, before income taxes, is used. It is not suggested, however, that such a rate of return would be acceptable to any situation. Obviously, a larger discount rate would automatically lower the evaluations in the following three instances.

Table 1 is a schedule of the actual income and cash expense of the subject property and is projected for the last three years of the flood. It indicates a cash return in excess of cash expended of $430,000. At operation end, this will be established on a property free and clear of any state restrictions and represents the best of operating circumstances and conditions.

Had we known prior to development of the property and projected the value of future dollars we would produce and had we discounted those dollars by 10%, then those dollars which we were to receive later would have been worth $249,000. Looking at it another way, were we satisfied with a 10% return on our invested money before income taxes and administration and office expense, the property then would have had such a stated value.

If, however, we had known previously that subject property's injection rate would be curtailed and had projected all figures of income and cash to be expended, then by using the same discount figure the evaluation of the property at the beginning would have been reduced to $182,000. (Table 2).

In like manner, had we known previously that development proration would exist, the property would have been valued at $200,000. (Table 3).

Had we been preparing at inception to purchase this acreage and had had the circumstances of economics set out before us as they now are, it merely would have been a case of offering to the seller a figure that would be related to the method of whatever conditions to which we would later have been subjected. In short, the difference in dollar value in such an instance would then become the burden of the seller, and as a result that property and all others capable of responding to waterflood would become less valuable.

Proration Inevitable

It is contended that it will be impossible to escape proration, and while this company and all others would naturally like to operate without state restrictions, it must be recognized that, if such a move were instrumental in improving the economic outlook, a good possibility does exist that we could gain a lot more than we would lose.

The author is well aware of the fact that there may be deficiencies, omissions, and inadequacies herein, which, when considered, may alter the complexion of the subject problem and its attempted solution. If, however, the article stimulates sufficient thinking on the part of waterflooders and culminates in not only our understanding of the problem but our willingness to help do something about it, then the presentation will have adequately served its intended purpose.

(Editor's Note: R. F. Lollar prepared and submitted this discussion of possible waterflood proration plans previous to the open hearings held recently by the Texas Railroad Commission to discuss proration of the state's waterfloods.) ★ ★ ★

Eastern District of API Elects 1960-61 Officers

New officers were recently elected by the Eastern District of American Petroleum Institute's Division of Production. Leaders chosen at the July 28 meeting in Pittsburgh are (seated, left to right): D. C. Hubbard, Ohio Fuel Gas Company, Columbus, Ohio, secretary-treasurer; Byron Maxwell, United Fuel Gas Company, Charleston, West Virginia, new chairman; Wendell S. Moore, Columbian Carbon Company, Charleston, outgoing chairman who was named chairman of the district's advisory committee; and Nace Mefford, Ashland Oil & Refining Company, Ashland, Kentucky, vice chairman. Standing are vice chairmen (left to right): H. T. Heuple, Manufacturers Light & Heat Company, Pittsburgh, Pennsylvania; Melvin Sauter, Sun Oil Company, Mt. Pleasant, Michigan; Earl Linn, Hiawatha Oil & Gas Company, Pittsburgh; J. Robert Hornor, Delaware Gas Company, Clarksburg, West Virginia; and John Kime, Preston Oil Company, Columbus, Ohio. Also elected vice chairmen, but not shown are: H. J. Magner, Delta Drilling Company, Pittsburgh; W. C. Best, Gulf Oil Corporation, Evansville, Indiana; W. F. Eiting, Humble Oil & Refining Company, Mattoon, Illinois; L. T. Evans, East Ohio Gas Company, North Canton, Ohio; and Fred Moran, independent, Owensboro, New York.

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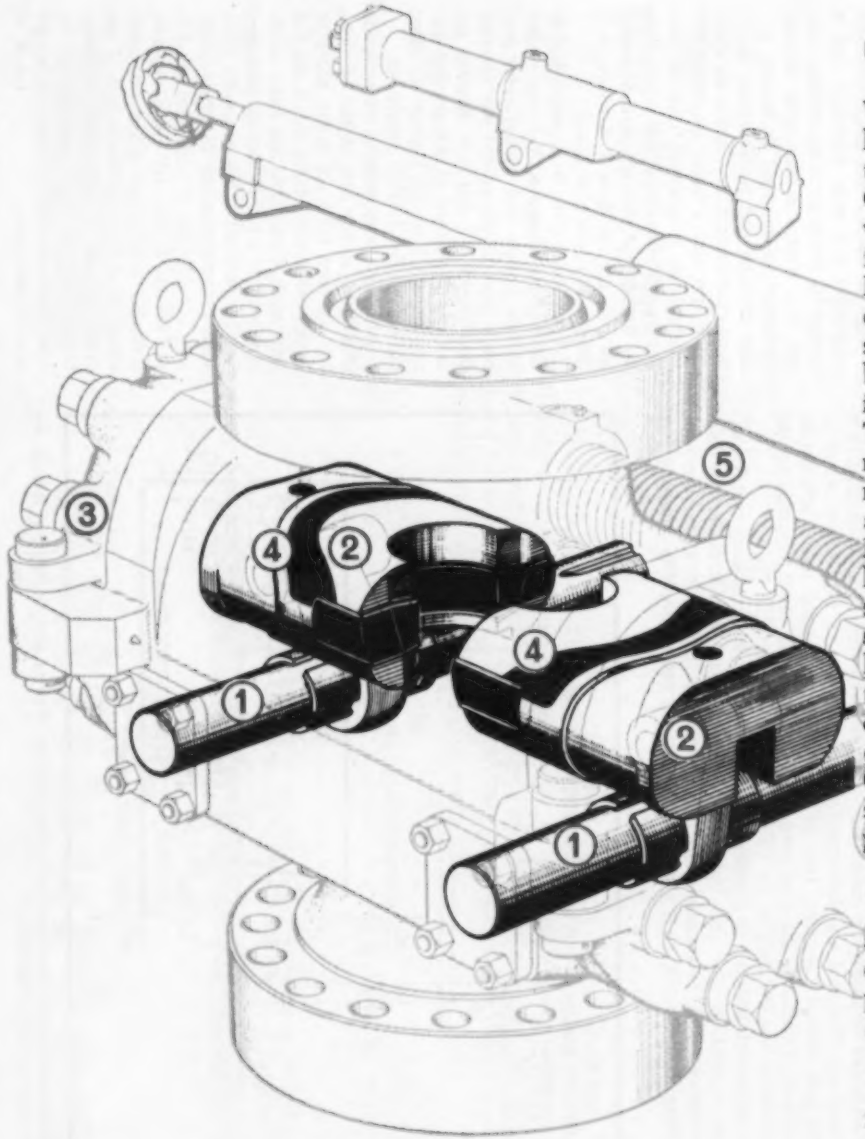

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(3) Compact hinged bonnets allow easy access for simplified ram changing. When fully retracted the roller and arm assemblies drop free of the rams. Ram bores are relieved toward bonnets to ease ram removal.

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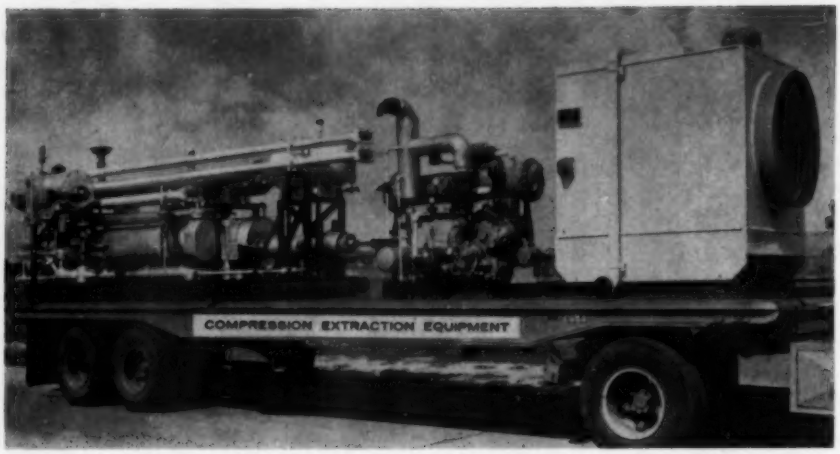
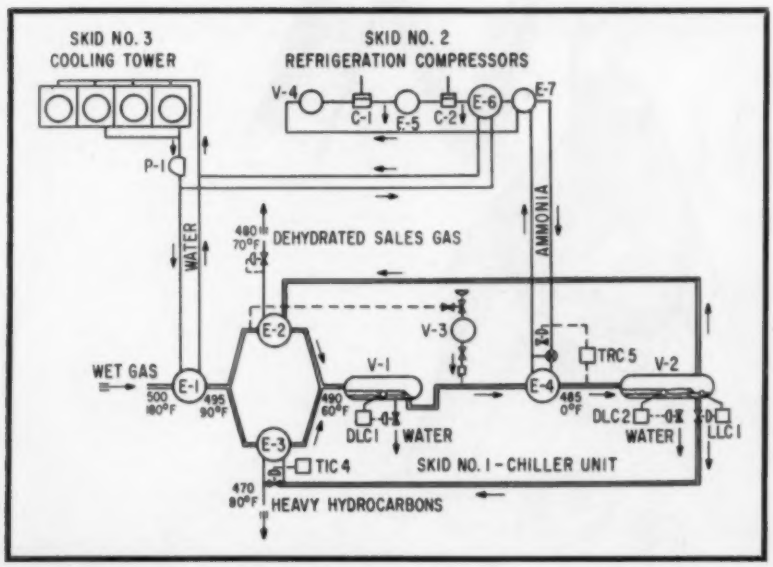


Prefabricated packaged field unit for compression-refrigeration extraction of liquid hydrocarbons from wet, low-pressure gas. Unit comes in three separately skid-mounted sections small enough to be loaded on one truck.

Packaged Unit Recovers Liquids From Low-Pressure Gas

THREE SKID-MOUNTED packaged sections small enough that all three can be carried on an ordinary truck bed make up the component parts of a new idea in liquid hydrocarbon extraction for field use. Designed and fabricated by the J. B. Beaird Company, Inc., of Shreveport, Louisiana, the first commercial unit was installed at the Fairview Roseland Station in Concordia Parish, Louisiana, for the Ingersoll Corporation. This first installation is handling about 500,000 cu ft of casinghead gas daily at a line pressure of 100 psi, although the unit is designed to handle up to 500-psi gas. Due to high liquid content of the gas, the unit is operating at a chiller temperature of 14 F and produces a condensate which is pumped eight miles to a fractionation plant. Residue gas is returned to the field for lease fuel.

This new gas processing unit is completely salvageable and utilizes the compression-refrigeration cycle for economical extraction. The complete unit consists of (1) the chiller; (2) refrigeration compressors and (3) cooling tower section.

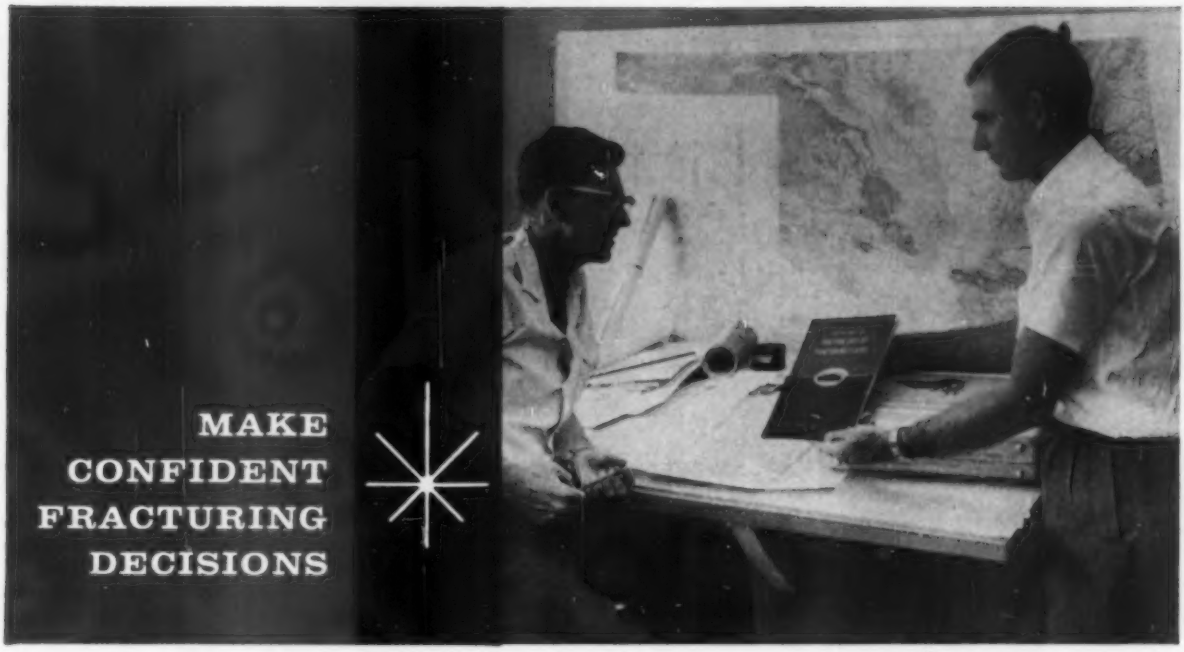


How the unit works is demonstrated in this schematic drawing showing fluid flow through the three basic sections of the field unit.

How it works. Wet gas enters heat exchanger E-1 (see drawing) and is cooled by water from the cooling towers. The stream is then split through hydrocarbon gas heat exchanger E-2 and through the hydrocarbon liquid heat exchanger E-3. Cooled to about 60 F, gas enters water knockout V-1 where water is removed from the condensate. Methanol is then injected as an anti-freeze and the stream enters ammonia evaporator E-4 where it is dropped to zero F or lower.

Final separation is accomplished in three-phase separator V-2 and hydrocarbon liquids and vapors enter feed back lines to pre-cooled gas entering exchangers E-2 and E-3. Residue gas is then discharged to the gas line and condensate goes to storage or other equipment for further processing.

Although compression refrigeration extraction is not new in the oil field, having been used for many years by larger processing plants, this is the first time such a principle has been incorporated into a pre-fabricated packaged unit for field use at low pressures. Four sizes are provided as matched units: (1) 1.5; (2) 3.0; (3) 5.0; and (4) 7.5-million cu ft per day rated capacity throughput. The packages can be interchanged to meet a wide range of gas compositions, so that this building block design makes it possible for the operator to custom-size his own unit for a particular need. ★ ★ ★



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The Part You Play in Unitization

A symposium on unitization by representatives of the various groups vital to a successful unit

FOREWORD: The Importance of Unitization

Mervin T. Miller, *Standard Oil Company of California, Western Operations, Inc., Taft, California*

"THE SUPREMACY OF NATIONS may be determined by the possession of available petroleum" explained President Coolidge in 1924 when he constituted a Federal Oil Conservation Board to study government's responsibility in the conservation of petroleum resources. Anticipating the trend to improve operating methods, industry had established the American Petroleum Institute in 1919. Petroleum, as a raw material, enters every facet of our economic, industrial, and social life. No other raw material penetrates as many fields of utilization. Today, conservation of petroleum and its allied products constitutes an international problem and is a matter of practical economic industry policy.

The unit operation, usually employing secondary recovery techniques, has evolved as having the most promise of attaining the conservation objects sought, through combining of properties to allow a single operator to produce the pooled area in the optimum manner. Petroleum, while in the reservoir, recognizes no property lines and no divided ownerships. It must be controlled throughout the entire reservoir for greatest ultimate economic recovery. Such control is best achieved through a plan of unitization that establishes equitable rights to the operating and royalty interests, with resultant necessary allocation or production.

Why Unitize?

Unitization provides the means to prevent over-drilling and over-building of pipelines, plants, storage, and other related facilities. It tends to stabilize what would be unnecessary and excessive costs, and also to conserve the necessary and vital reservoir energy. Without unitization, drilling is by property lines, the "law of the chase" applies, and production peaks sooner leaving a costly excess capacity in facilities.

The oil pool is not shaped by lease lines and, to be fully and efficiently produced, requires the consummation of a unit to permit secondary recovery operations such as recycling, pressure maintenance by the injection of gas, water, or a miscible substance. Thus, competition becomes in reality not the law of the chase, as between the various properties and companies, but it lies in and is inherent and basic to unitization itself. As a result, each new unit combined with prior units becomes a competitive force within the industry, pointing the way to a more efficient operation, while accomplishing greater conservation of an essential natural resource.

How best can the foregoing be accomplished? Who or what group should lead in the formation of a unit? What tools are available to those evaluating the advisability and methods of unitizing? Who should be primarily responsible, and what should be its character? These and many other questions are apparent. However, the answer appears reasonable to place responsibility and leadership on management. Accomplishment can best be effected through this medium, as herein lies both the initial and final power of decision. Management has access to and control of necessary capital and can best coordinate the effort of other industry and producing segments.

In accepting this leadership, there must be recognition of responsibility and full understanding of the ethics involved. Equity must be established as the end result and govern between interests to permit all to benefit, including the consumer. Above all, the unit is a purer form of oil exploitation and, to succeed, it must be handled by an enlightened leadership.

The Unit Team

The unit may be brought to successful fruition through coordination of the various organizational setups and interested parties. These are: engineering, landman, legal, landowner, accountant, operator, government agency, and capital. The first four form the basic nucleus through which management may work. They are the key to resolution of the issues involved. Naturally prompted by economic considerations, management must start with sound engineering considerations. Nothing can be reasonably done until the engineer has completed his analysis.

In addition to economic considerations, there is a moral obligation to protect fully the irreplaceable declining natural resource of oil and natural gas and its included liquids. The most economic method should be employed to maximize recovery from the reservoirs.

The unit is one of the oil industry's most efficient and economical methods for securing the most economical recovery of production in primary and secondary recovery operations. Unitization (through equitable rights), reviewed in the light of scientific knowledge respecting the relationship and function of oil, gas, and water in a common reservoir, provides a more accurate distribution of the unitized substances to all interests. The industry can do no less than foster the development of units to protect and conserve a vital natural resource.

Continue

Adapted from a symposium of papers presented at the Spring Meeting of the Pacific Coast District, Division of Production, American Petroleum Institute, Los Angeles, California, May 12 and 13, 1960.

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The Petroleum Engineer and Unitization

W. B. Emery II, *The Ohio Oil Company, Los Angeles, California*

THE PRIMARY PURPOSE of unitizing oil and gas pools is the conservation of a valuable natural resource. Complete unitization effectively erases lease lines so that the hydrocarbon accumulation can be exploited as a single productive unit. By treating the accumulation as a single unit, wells can be drilled where necessary, and producing operations conducted so that the maximum ultimate economic recovery can be obtained at the minimum possible cost.

These technical and economic advantages of unit operation are now recognized and accepted by petroleum engineers and the oil industry generally. It is equally well known these advantages must outweigh the disadvantages resulting from the loss of individual control of properties before unitization is practical. Regardless of the recognized benefits of unitization, pride of ownership, misunderstanding and fear of unit operation, and so-called "profitable obstructionism" sometimes do hinder voluntary unitization efforts.

The industry has made considerable progress in overcoming resistance to voluntary unitization. The engineer has become more effective in evaluating and weighing the effects of unitization upon his principals. His necessary adherence to the conservation regulations of various governmental associations dealing with conservation has provided a better informed approach to the problem by most operators.

This paper deals with the engineering functions in accomplishing unitization of two types of properties. The first, and most familiar, is the unitization of producing properties, and the second, less familiar to engineers, is the unitization of lands for the drilling of exploratory wells.

Unitization of Producing Properties

The primary purpose and the advantages, disadvantages, and difficulties mentioned above apply generally to the unitization of producing properties. For instance, if the properties are completely developed, unitization is usually the first step toward initiating secondary recovery operations or to doing something else to improve an already existing condition. If the properties are not developed, the objective of unitization is then twofold; first, to allow completion of the development in an orderly manner, and second, to provide for efficient primary and perhaps secondary producing operations.

Whether the properties are completely or partially developed, the function of the petroleum engineer before and after unitization is quite similar. Unitization negotiations are usually initiated by the working interest owner having the largest interest in the reservoir. Petroleum engineers are assigned the job of gathering, organizing, and analyzing all pertinent data. From this analysis they then recommend to management the tracts or parcels of land to be included in the unit area and initial participating area in the case of a partially developed pool. They recommend a basis for participation and calculate the participating percentage for each parcel of land. The bases of participation most commonly used are productive acreage, the amount of oil or gas in place, the remaining recoverable oil or gas by primary and secondary means, the value of the oil and gas in place, cumulative production, or various combinations of these factors.

Engineers also recommend methods for enlarging the participating area for a pool not completely developed, so that eventually all productive lands are included in participation and production allocated to these lands in proportion to the value each tract bears to the total value of the pool on whatever basis of participation has been adopted. The ultimate goal is to include in participation all productive lands overlying the oil or gas pool, while at the same time excluding nonproductive lands from participation so as to assure each participant his fair share. The engineers are frequently asked to make recommendations affecting adjustments of investment for wells and facilities among the various operators in the pool. When appropriate, they recommend secondary recovery programs to be followed upon unitization.

After unitization has been accomplished, an engineering committee, usually consisting of a representative from each working interest owner, works with the unit operator's engineers in making reservoir and economic studies so that recommendations for the most efficient development and exploitation program can be made. These recommendations include when, where, and how to drill wells. They also deal with surface and subsurface equipment, whether or not fluid injection programs should be adopted, and if adopted, what type of fluid is to be injected, and where. Further, the engineering committee is charged with the responsibility of calculating participating percentages in accordance with the enlargement formula when the participating area is enlarged by extension drilling.

The API has developed comprehensive and useful standard forms of unit agreement and unit operating agreement which are real timesavers in the unitization of producing properties. The U. S. Government also has a standard form of unit agreement which is helpful, even though federal lands may not be included in the unit. This form, adapted to the conditions by negotiation with the government, is advisable when the unit is to include federal lands.

Unitization of Wildcat Prospects

For the purposes of the following discussion, unitization of wildcat prospects contemplates complete unitization, including the execution of a unit agreement and unit operating agreement, as distinguished from simple pooling of lands for the drilling of a wildcat well.

From an engineering standpoint, the primary purpose of unitization of a wildcat prospect is the same as the purpose of unitizing producing pools; specifically, maximum ultimate recovery of any hydrocarbons discovered at minimum expense. The advantages, disadvantages, and some of the difficulties mentioned in regard to producing pools

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also apply here. A major difference, of course, is that no one knows whether or not a hydrocarbon accumulation underlies the lands to be unitized. This lack of knowledge is, in a way, really one of the major advantages of unitizing prior to discovery, since all parties to the unit enter into the agreement with untested lands. Thus there should be no unjustifiable demands for special consideration by any of the parties.

Another big advantage of unitization before discovery is that the basic agreements are in existence in the event of discovery, permitting efficient development and producing operations from the outset. However, if the test well or wells are dry there is the disadvantage of the waste of time and effort required in unitizing the lands.

Engineering Advantages

With regard to an engineer's function before unitization, his most important duty is to offer recommendations on the engineering advantages and disadvantages of unitizing a particular wildcat venture. To arrive at a recommendation he must analyze several things. In cooperation with the geologist, several factors should be determined; for example, the extent of the geological feature to be tested, the number, location and depth of the test wells proposed, and whether gas, oil, or condensate is the probable type of production to be obtained in the primary objective zone. With this information and an estimate of the reservoir characteristics of the objective zone, he should estimate the possible reserves and the cost of developing and producing such reserves so he can judge whether or not the size of the target warrants unitization. In cooperation with the landman he should acquaint himself with the ownership of various interests on and around the geological feature to be tested, together with basic lease requirements, before recommending unitization. He should also have a knowledge of the supply problems involved in the wildcat area, together with the costs of moving in, drilling test wells and development wells, where production can be marketed if developed, and any other factors pertinent to the logistics of the particular situation.

While these problems are not as clear cut or technical as the problems an engineer faces prior to unitization of a producing pool, they require vision, ingenuity and judgment for a satisfactory solution. The subjects outlined form an interesting field for engineering study before recommending unitization.

Once the decision to unitize is made, the engineer must cooperate with geologists, lawyers, landmen, and management in preparing the necessary agreements in an effort to assure consideration of all engineering problems. He should satisfy himself that the proposed unit area is large enough to effectively control the geological feature to be tested. Usually provisions are included for enlargement or contraction as drilling information becomes available, so the original unit area size may be not be too critical.

Drilling Participation

The engineer should examine the proposed basis for sharing the costs of test wells. The principle usually followed is that only those sharing in the costs of such wells are entitled to the information developed by the drilling, and also the principle that in spite of unitization no one should be precluded from drilling their own lands.

Unless participating percentages are initially fixed for both working interest owners and royalty interest owners, the engineer should be concerned with the provisions for formation, enlargement, contraction, or joining of participating areas, remembering that the basic principle here is to include all productive lands in participation, and to exclude all nonproductive lands. Enlargement of participating areas is accomplished by successful extension drilling, while contraction of both participating areas and the unit area is based on the drilling of dry holes. In practice, contraction of established participating areas has seldom been used.

The engineer should recognize that provisions not usually encountered in unitization of producing pools are necessary in wildcat units. One of these provisions is the election by each working interest owner as to whether or not he desires to participate in the drilling of subsequent development wells, even though he may be included in a participating area. This provision prevents a working interest owner from being voted into drilling wells which he believes are unnecessary, or which, because of his economic situation at the time, he cannot afford. The drilling election provision complicates the agreement by necessitating back-in provisions for nondrilling parties, and the back-in provisions, in turn, complicate the investment adjustment, but the benefits easily warrant the inconvenience.

Usually the back-in clause provides for the recoupment by the drilling parties of the nondrilling party's share of the cost, plus a penalty, both recoverable only from production allocated to the tract on which the well was drilled. This avoids complete interruption of the nondrilling party's unit income if he has other participating tracts. When these costs and the penalty have been recovered, the nondrilling party is restored to his full participation.

Another very important consideration for the engineer is to be sure participation for wells causing enlargements of participating areas is in proportion to reserves contributed by the extension well. For example, where an acreage basis is used, the extension well should bring in at least as much production acreage as the ultimate optimum well spacing. Otherwise, the reimbursable costs to the drilling party should be proportionately reduced. The same principle applies where other bases of participation are used. Reimbursable costs to the working interest owners drilling the extension well should be limited so they are in line with costs of other wells drilled in the participating area.

The engineer should also assure himself that voting control and back-in provisions for nondrilling parties are such that a reasonable majority of working interest owners can proceed with the drilling of development wells, and can adopt, change, or terminate fluid injection programs, including the building of plants and other necessary surface facilities. However, the building of large, expensive plants is usually covered by a provision requiring special consent at the time.

Many other legal, accounting, and business provisions are necessary in a wildcat unit agreement, and it is readily apparent that much time and effort can be expended uselessly if the exploratory venture is unsuccessful. However, the advantages of having this basic work done in the event of a discovery of a major reserve will compensate the working interest owner for any time spent in unitizing dry holes.

After discovery, the engineer has the same functions and duties as outlined for producing reservoirs. In addition, he must cooperate with the geologists in recommending a development drilling program. The recommendation should specify information to be obtained during the development drilling, to assure that reservoir data is available when needed for the enlargement or contraction of participating areas and the unit area.

Acknowledgment

Permission of The Ohio Oil Company to publish this paper is gratefully acknowledged.

Continue

LATEST SHAFFER "LWS" ADVANCEMENTS MARK NEW ERA IN BLOWOUT PREVENTERS

With modern drilling programs constantly probing into more and more remote areas of the globe, it was inevitable that blowout preventer equipment would eventually become lighter in weight, easier to handle and transport—*without sacrificing pressure handling abilities or basic operating features.*

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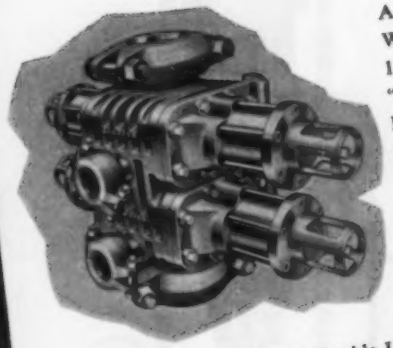
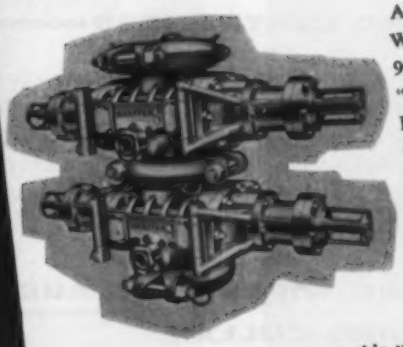
Now Shaffer has taken another major step ahead of the field with announcement of these two additional "LWS" Preventers having even higher pressure ranges than the original "LWS" units, coupled with important savings in weight that assure lower transportation costs and greater handling ease . . .

6"—3,000# W. P.



A new 6"—5,000# W.P. (6" Series 1500) Shaffer Type "LWS" Hydraulic Blowout Preventer with a *Working* Pressure of 5,000 PSI (*Test* Pressure of 10,000 PSI) and a 7-1/16" Bore. This unit is available in both *Single* and *Double* designs—and the Double Unit has a total weight of only 2,610 lbs. (as compared with the 5,700 lb. weight of comparable equipment heretofore available). *That's a saving of 55% in weight—with no sacrifice in operating features!*

10"—5,000# W. P.



A new 10"-3,000# W.P. (10" Series 900) Shaffer Type "LWS" Hydraulic Blowout Preventer with a *Working* Pressure of 3,000 PSI (*Test* Pressure of 6,000 PSI) and an 11" Bore. This unit, also, is available in both *Single* and *Double* designs—and the Double unit has a total weight of only 3,850 lbs. (as compared with the 6,965 lb. weight of comparable equipment heretofore available). *That's a saving of 45% in weight!*

All the above "LWS" Preventers incorporate the latest Shaffer advancements . . . **Swinging END-Opening Doors** for quick, simple ram changes without loss of operating fluid—**Positive Direct Hydraulic Drive** with each ram on the same shaft as the operating piston (no levers, yokes or other complex connections) . . . **Quick-Drain Ram Compartments** that prevent detrimental accumulation of mud and sand—*and many other unique advancements found only in Shaffer Preventers.*

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SPECIFICATIONS ON POPULAR SIZES OF SHAFFER TYPE "LWS" BLOWOUT PREVENTERS

Nominal API Size	Working Pressure	Test Pressure	Vertical Bore	Approx. Weights		Approx. Saving in Weight*
				Single	Double	
6"—3,000# W.P. (6" Series 900)	3,000 PSI	6,000 PSI	7 1/16"	780 lbs.	1,420 lbs.	67 %
6"—5,000# W.P. (6" Series 1500)	5,000 PSI	10,000 PSI	7 1/16"	1,410 lbs.	2,610 lbs.	55 %
8"—3,000# W.P. (8" Series 900)	3,000 PSI	6,000 PSI	9"	1,100 lbs.	1,950 lbs.	64 %
10"—3,000# W.P. (10" Series 900)	3,000 PSI	6,000 PSI	11"	2,100 lbs.	3,850 lbs.	45 %

*As compared with comparable equipment now in use.

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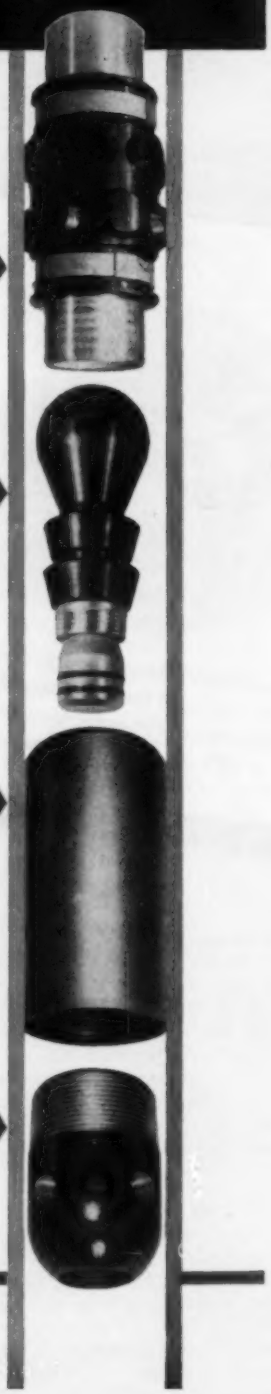

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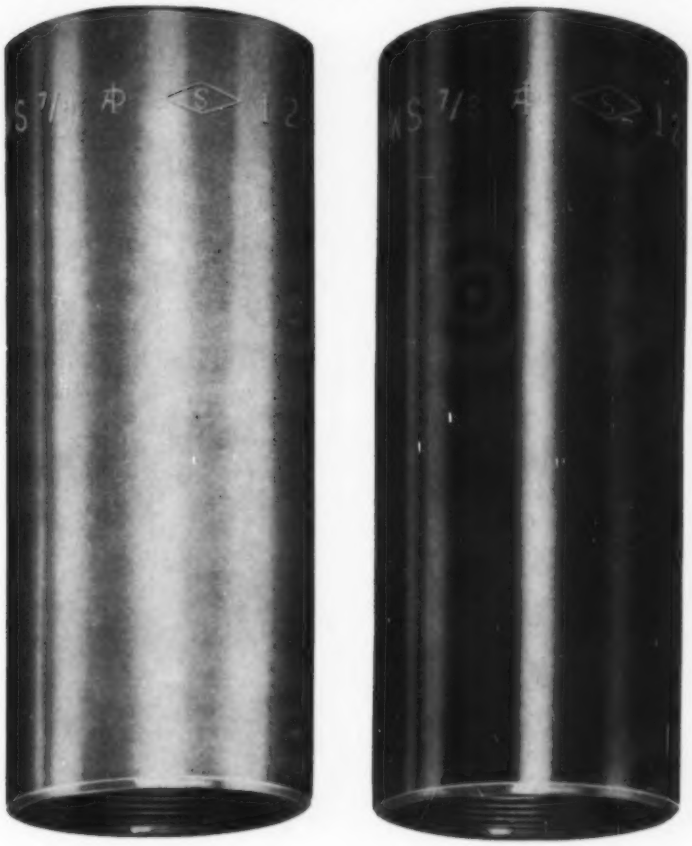
"Oilwell" Sucker-rod couplings machined from leaded alloy steel at high cutting speeds and finished on a centerless grinder. Couplings are shown *before* and *after* heat treatment.



USS leaded Alloy Steel bars speed up machining...produce a superior finish.

This sucker-rod coupling is a good illustration of how **leaded** alloy steel in the annealed condition can increase machining speeds, produce more parts per hour, and assure an exceptionally fine finish. Cutting tools don't have to be changed as often, threads are smoother and the ends machine accurately. ☐ The steel used in the coupling is leaded, an Open Hearth, Ni-Mo Leaded Steel. Cutting speeds of 268 to 313 r.p.m. were used with an .007" feed producing 550 to 900 couplings before having to change cutting tools. Other users have reported production increases of about one-third over unleaded alloy steel. ☐ If you are looking for a superior product, we urge you to try USS Constructional Alloy Steels, such as 4140, 4145 or 8620 with lead. In addition to good machining, you get high resistance to abrasion and corrosion, better finish and longer product life. ☐ You can obtain USS Leaded Alloy Steel bars and semi-finished steel in all the usual sizes of rounds, squares, hexagons and flats. If the leaded alloy grade you need is not listed here, write or call the nearest office of United States Steel or write to United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

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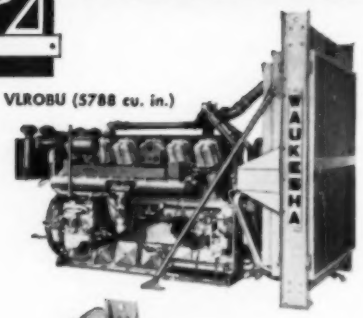
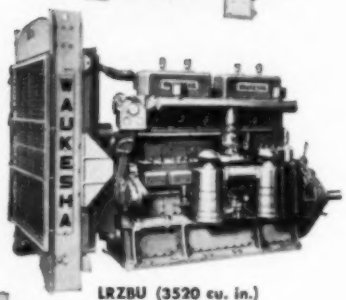


VLROBU (5788 cu. in.)



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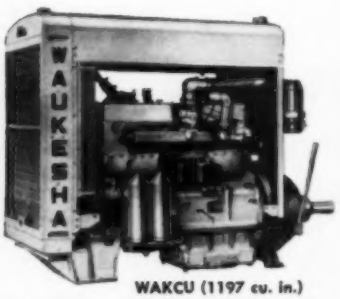
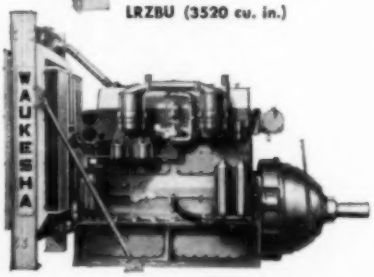


WAKCU (1197 cu. in.)



NKRBU (1905 cu. in.)

496

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ICK	4-A	2½x3⅛	61	36-1600	5	6	8	9	11	12	14	15	16
FC	4-Ir	3¼x4	133	88-1200	12	16	20	23	26	28	30	31	31 @ 2600
180-GKB	4-AC	3⅜x3¾	155	112-1400	15	20	25	30	34	37	39	42	43
XAH	4-Ir	3⅜x4½	186	120-1400	16	22	27	32	36	39	42	42	
190-GLB	6-A	3¾x4	265	192-1200	29	36	44	50	57	62	66	67	67
195-GL	6-A	4 x4	302	214-1200	32	40	49	57	63	68	72	75	76
195-GK	6-A	4⅛x4	320	217-1400	32	40	49	58	66	74	80	87	93
135-GZ	6-A	4⅜x5	451	315-1200	48	60	72	83	93	103	112	118	122
140-GZ	6-A†	4⅝x5½	554	395-1000	60	75	90	104	116	127	136	144	149
145-GZ	6-A†	5⅜x6	817	597-800	91	113	135	155	174	191	205	219	230
WAKC	6-A†	6¼x6½	1197	900-800	131	171	204	236	264	283			

LARGE NATURAL GAS ENGINES					600	700	800	900	1000	1100	1200
NKRB	6-AC†	7 x8¼	1905	1505-600	172	197	220	244	266	286	306
LRORB	6-AC†	8½x8½	2894	2270-800	252	300	346	385	420	445	464
LRZB	6-AC†	9⅜x8½	3520	2700-800	305	357	409	450	485	515	537
VLROB	12-AC†	8½x8½	5788	4590-600	524	601	672	743	807	859	890

*FEATURES: **4, 6, 12**—No. Cylinders; **A**—Aluminum Pistons; **C**—Counterbalanced; **Ir**—Cast Iron Pistons. †Special high compression ratios for higher horsepower and better economy are available for use with dry methane type gas with high heat value of 1150 BTU/cu. ft. or less.

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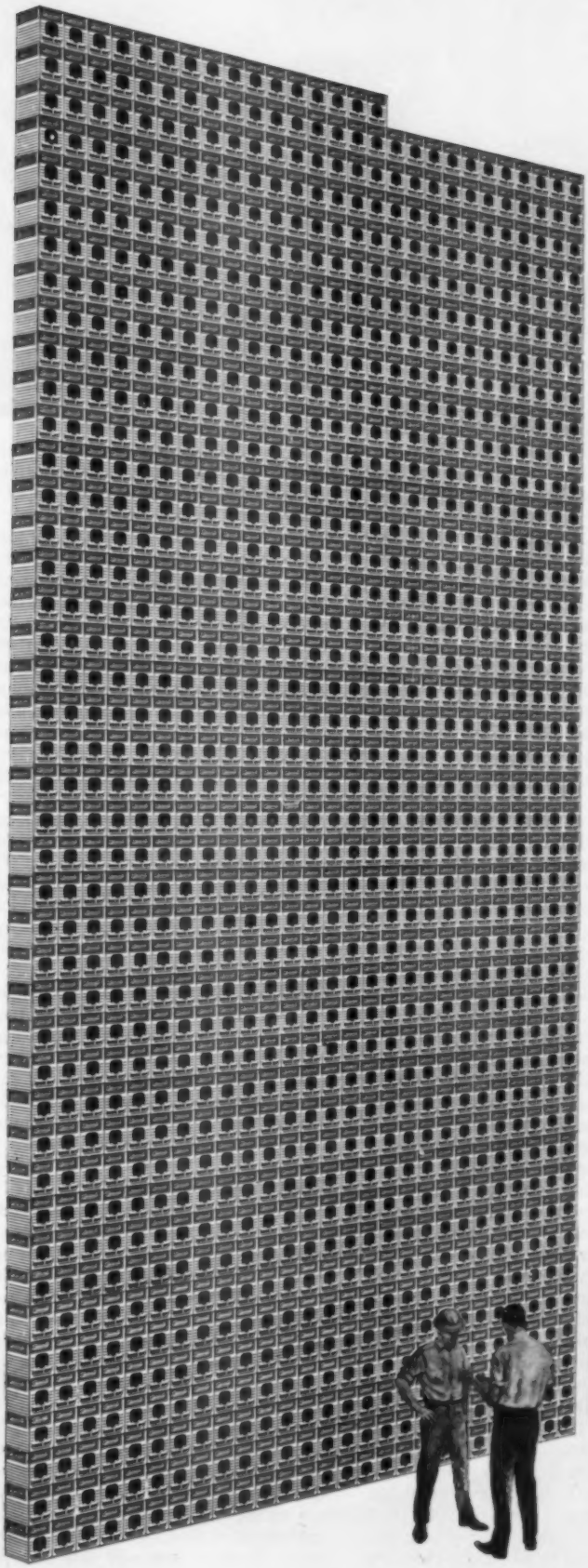

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The Landman's Role in Unitization

James C. Austin, *Richfield Oil Corporation, Los Angeles, California*

DURING RECENT YEARS the petroleum industry has become increasingly aware that unitization, when properly conducted, can produce prodigious benefits for those having interests in oil field pools; however, the task of bringing about unitization can be almost as prodigious as the benefits derived.

Unitization is a complex and time-consuming task and, unless a certain basic reality is faced at the outset, it may be a fruitless one. In most cases a team composed of petroleum engineers, geologists, lawyers, accountants, tax specialists, civil engineers, and landmen, is required for each project. It is not uncommon for several years to elapse before the unitization documents are ready for submission to the various interest owners for signature. When this time does come, the unitization documents will represent a large expenditure of time, effort and money, yet they may be absolutely and completely worthless if operators and royalty owners refuse to buy them. This, then, is the reality that must be faced throughout the unitization effort: the end product must be so sound and fair that it is salable to reasonable men and, in some cases unfortunately, to unreasonable men.

Since, in unitization, the principal role and ultimate goal of the landman is to sell the unit agreement to the royalty owners and, at times, to those operators who did not actively participate in the formation of the unit, and since all the time, effort, and money which have gone into the unitization effort are lost unless the unit agreement is sold, the landman's role is vitally important.

Unit Contracts

It may be well to point out that unitization documents generally consist of two basic contracts. One is the unit agreement whereby the working interest owners and the royalty and other interest owners agree to unitization. The other is usually referred to as the "unit operating agreement" and it is usually an agreement between the various working interest owners only as it relates primarily to operating management and to the method by which costs are apportioned among the working interest owners.

Obviously, before any unitization project can progress very far the working interest ownerships within the proposed unit area must be determined. Since land titles are usually within the province of the land department, the determination of working interest ownerships as well as royalty, overriding royalty and oil payment interest ownerships, should be the responsibility of the landman.

The drafting of the necessary legal documents is, of course, the responsibility of an attorney. However, the landman should assist the attorney by supplying lease data, the legal description of the lands involved, and other information necessary in the preparation of these documents. Frequently the attorney and landman, after consultation with the technical people involved, will find it necessary to work out provisions covering such things as independent drilling and applicable penalties, methods of adjusting costs of unit facilities, and the consequences of title failure, and to negotiate these points with the attorneys and the landmen of other companies involved in the unitization project.

Unfortunately, royalty owners are frequently ignored until such time as they are asked to give their consent to a unit agreement and this can result in unnecessary delays in effecting unitization. In many instances royalty owners do not understand what is intended to be accomplished by unitization and the secondary recovery methods of operation to be conducted thereunder. This results in a failure to appreciate the benefits to them which may be derived therefrom. It is, therefore, important during the early stages when unitization plans are being formulated, that the geologists, engineers, and landmen arrive at a plan by which the royalty owners can be acquainted with the need for unitization and its fundamental importance to both the royalty owners and the operators. Such a plan, if properly carried out, will do much to simplify the landman's principal role of selling the unit agreement.

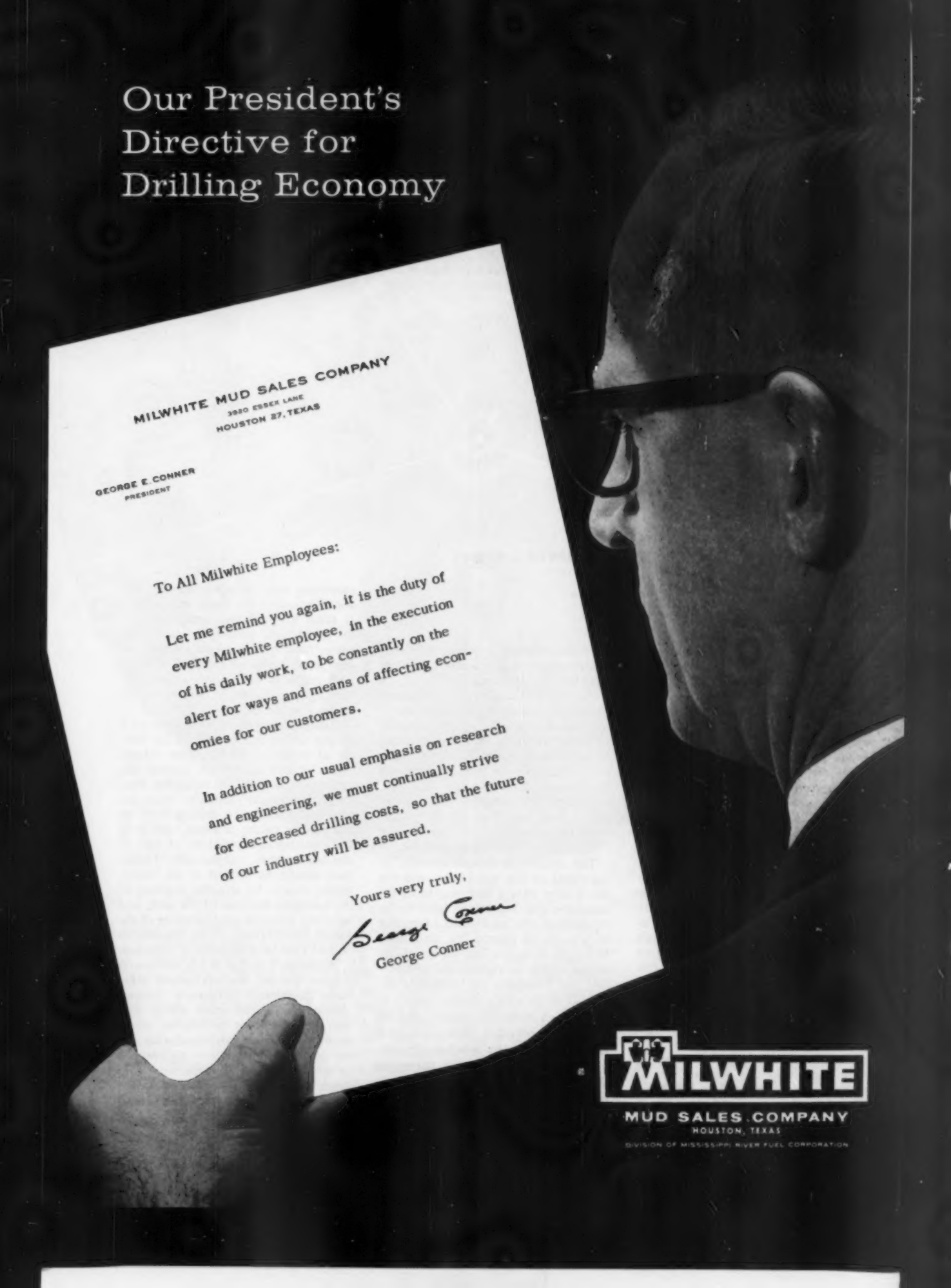
In the case of the royalty owners having the larger interests, it is often advisable to afford them the opportunity to be represented by an independent petroleum consultant at the engineering meetings. Such an offer, however, should not be made until there is agreement in principle on the part of the operators with respect to the area to be unitized, the plan of future operations, and the formula to be used in determining participating equities; the obvious reason for this prerequisite being that if the operators cannot agree in principle they should not invite further differences of opinion.

In addition, the landman should be alert to assist the various technical people involved in correlating activities, in helping to resolve policy or non-technical questions which are not of sufficient importance to justify reference to management, and in generally maintaining proper liaison. Sometimes it may be necessary to modify preliminary provisions which may be objectionable to one or more of the technical people, and the landman can often be of help in arranging and sitting in on discussions which will result in resolving divergent viewpoints to the satisfaction of all concerned.

Ounce of Prevention

During the critical period in which the unitization plan is being formulated, he may be able to eliminate many undesirable features which would present sales resistance when the time comes to perform his principal role. Such features might be relatively unimportant to the technical people involved, but the necessity for their elimination might be readily apparent to anyone other than the party charged with selling the agreement. Most certainly, the landman should be working closely with the technical people who are attempting to put together the unit agreement so that he will fully understand its provisions and will be pre-

Our President's Directive for Drilling Economy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To All Milwhite Employees:
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Yours very truly,
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pared to translate these technical provisions into layman's language.

Although at times it may be difficult to believe, there will, in most cases, eventually be agreement on the part of the operators with respect to the unitization plan and the documents by which the plan is to be accomplished. When this does occur, if the landman is thoroughly familiar with all aspects of the unitization agreements and the steps by which the participants arrived at the final plan, he is then, and only then, prepared to proceed with his principal responsibility of securing the royalty owners' consent to the unit agreement. He will have to explain the plan to the royalty owners; he will have to educate and convince those who are non-believers; and to those who are believers, but who question the equity provisions of the agreement, he must be able to justify such provisions. A thorough knowledge and understanding of the facts and a solid conviction of the truth in his arguments in favor of unitization are his best tools for accomplishing the job.

The landman must recognize at the inception that, in spite of the truth of the claims of the engineers, lawyers, and other technical staff, as to the merits of the unitization plan and the unit agreement embodying it, in the final analysis, the royalty interest owners should and will judge the unit agreement upon its participation factors. He must, therefore, throughout the entire unitization effort, do everything possible to aid in the production of a unit agreement which is fair and equitable, which is competently drafted on the basis of sound engineering principles, and which will benefit and give proper protection to all interest owners.

UNITIZATION

Legal Aspects of Unitization

Richard C. Bergen, *Partner, O'Melveny & Myers, Los Angeles, California*

IT HAS BEEN SAID that, looking at the size of the legal documents, you can tell the size of the unit. In the case of the recently formed units involving two fault blocks in the Wilmington oil field in the Los Angeles Harbor area where subsidence has been a problem, it has been suggested that the legal documents might be used to cover the Wilmington-Long Beach subsidence bowl, an area approximately 20 square miles and 26 ft deep at its center. But there are complicated problems in forming units not all of which are created by lawyers.

The simplest units to form are those created in advance of or upon discovery of oil, and, of course, this is highly desirable from an engineering and conservation standpoint in order to permit pressure maintenance. However, the avariciousness of human nature frequently prevents voluntary unitization prior to complete, or at least partial, depletion. At least one operator usually thinks he has a special position on the structure, or wants what has been called a "fair advantage." As a result, most of our voluntary units are formed really too late to achieve the maximum advantage from a conservation standpoint, and to require compulsory unitization before sufficient facts are known about the reservoir to permit a reasonable determination of equities, presents constitutional problems.

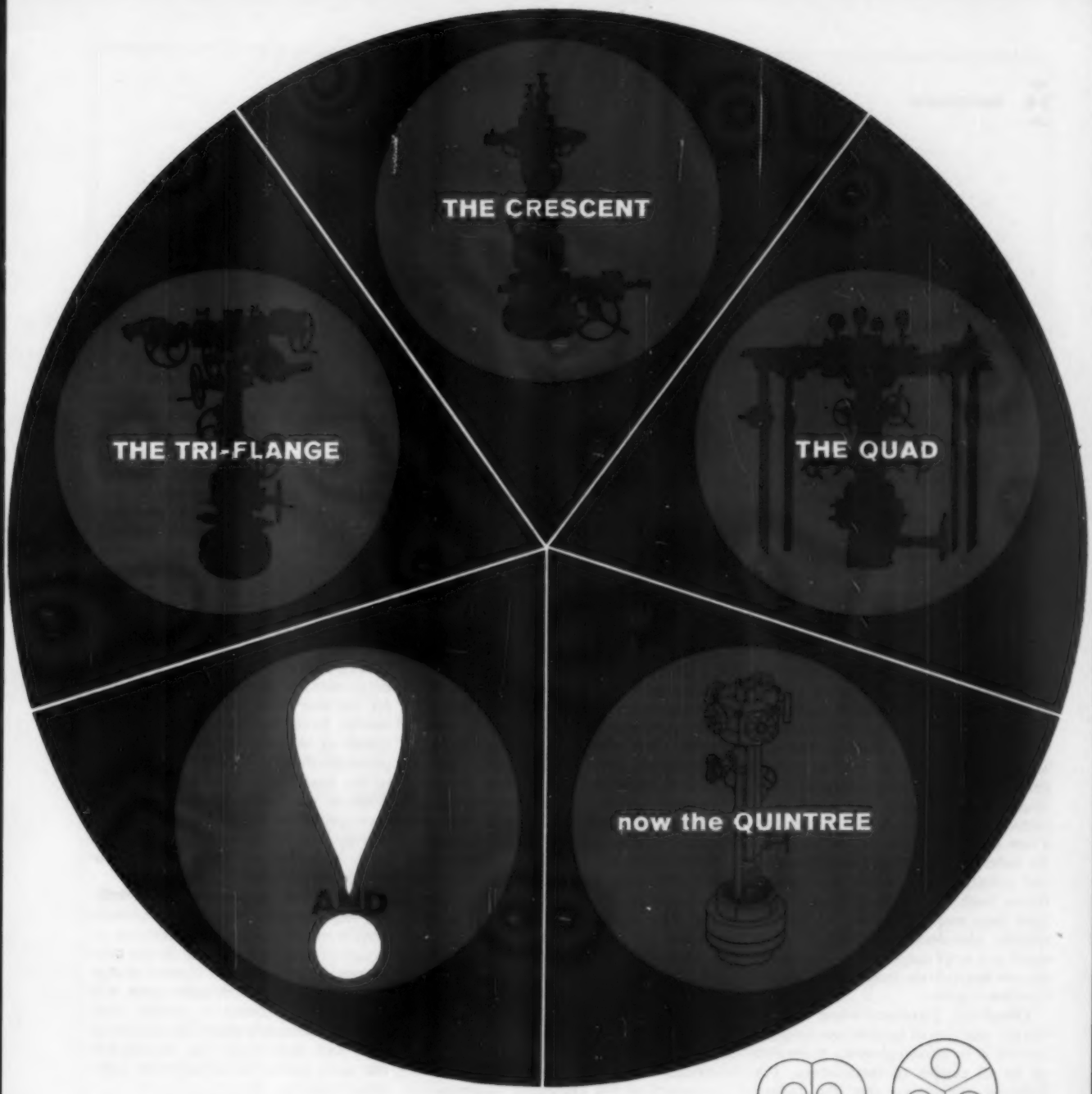
The constitutionality of compulsory unitization statutes applicable to developed fields is now generally accepted, although politically they are still anathema in many states. However, when our early surveyors laid out property lines for our farms, ranches, and cities, they were not thinking of oil pools, and if they had, they could not see under the ground and, as a result, fence lines and pool lines rarely coincide.

This creates the difficult problem of the rights of the non-joiner, and the courts have gone a long way to fill the legislative gap and refuse relief to the recalcitrant who has refused a fair offer to join in an appropriate unit plan. However, there is a limit on the ability of the courts to expand the common law, and it requires the technical competence of an administrative agency to rule in such matters as equities and the limits of the reservoir. How can a court trained only in law intelligently consider whether the equity formulae should be based upon productive acre-feet, number of wells, past production, present worth of primary reserves, susceptibility of the particular sands to secondary recovery operations, or any combination of the foregoing factors? It takes the technical competence of an appropriate administrative agency whose members have been selected for their competence in this field to solve such problems and to avoid many pitfalls that are present in any pooling or unitization program.

The problems involved in creating a proper voting procedure and the matter of arranging for a proper adjustment of investments are beyond the proper scope of judicial functions; also, whether a credit should be given for tangible or intangible drilling costs, or for pumps, tubing or tanks, should be an administrative problem, at least in the first instance, and the judicial function should be limited to an appropriate review. So also the problem of the size and duration of the unit, and whether, after the establishment of the initial boundaries, these boundaries should ever be contracted or enlarged.

Although I realize it is a confession against interest, lawyers cannot solve these problems, particularly lawyers dressed in judicial robes whose time and thought must be exerted in so many other fields. My conclusion and my plea is a simple one — we lawyers, in or out of judicial robes, need help from legislatures and engineers so that we may implement accepted conservation practices.

Continue



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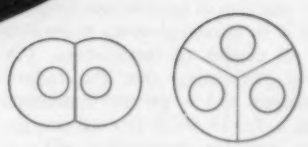

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A Landowner Looks at Unitization

E. P. Burtchaell, *Kern County Land Company, San Francisco, California*

LANDOWNERS, like oil operators, are interested in the maximum possible financial return from their lands. It is, therefore, usually assumed that unitization should have the same appeal to the landowner as it does to the operator. But this is neither true in theory nor in practice. Many circumstances cause the landowner and oil operator to analyze unitization under different standards. It is these standards for considerations of units which will be discussed more fully at this time.

First, it would be advisable to qualify our discussion as to type of landowner and unit program. The term "landowner" encompasses quite a conglomeration of different persons or corporations owning or controlling interests which can range from fractions of a percent of an overriding royalty to a major or controlling interest in any particular oil or gas field. To cite just a few examples — landowners include the federal and state governments, city and county governments, our Armed forces such as the Navy and Army, both large and small trusts, or holding estates, universities, railroads, both small and large corporations, and many private individuals from large farmers to office workers.

Obviously, therefore, when discussing the reaction of landowners to unitization, it is meaningless to generalize as to all classes of landowners. The folly of presuming that the federal government and a private individual owning a 1/128 ORR interest are going to consider unitization alike is obvious. Each group or class should, therefore, be discussed separately. Even then generalizations can be dangerous because we are dealing with individuals or groups of individuals who seldom think alike.

Another qualification is a limitation as to type of unitization. The landowner's viewpoint on unitization is necessarily dependent upon the type of unit operation under consideration. Without going too much into detail on this subject, it is certain that a landowner will look quite differently on a drilling unit proposal as compared to a production type unit. Here again the landowner's conclusions will depend to a very large degree upon the classification of landowner.

This discussion is confined to that classification of private landowners which derives an appreciable portion of its income from oil and gas royalties. In general, the financial size of this class of landowner is not critical to this discussion. Also, the discussion considers only the production or reservoir conservation type of unit — not the drilling unit.

The problems oil operators have in signing up landowners in unit plans invariably can be traced to one item — the substitution of uncertainties for known quantities. Repeating our opening statement that landowners are as interested in the maximum financial return from their properties as the oil operator, why the reluctance of landowners to join unit plans? Obviously if the benefits of unitization were mutual, and positive, there would be less difficulty in negotiations with landowners.

Unfortunately, the claimed benefits are not certain. They are opinions based upon engineering and geological studies which result in generalized conclusions as to possible future reservoir performance under various operating conditions. Of course, the probable accuracy of this calculated future performance is only as good as the limiting required assumptions made by the operator, and is also reduced by many hazards which cannot be evaluated at all.

It can rightfully be argued that the oil operator is also taking the same gamble as to possible future reservoir performance. Certainly this is true but usually the oil operator enjoys immediate certain benefits of unitization not enjoyed by the landowner, such as elimination of duplicate services. As most landowners are not concerned directly with operating and development costs, their reductions are of no benefit to landowners whereas their savings are of great benefit to the oil operator.

Consolidation of holdings under one common operator normally results in a reduction of operating costs for units as compared to the aggregate costs of individual operations in the same field by different operators. This benefit occurs as soon as the unit operator takes over and is not related to any calculated future reservoir performance. He is also immediately relieved of such limitations as he may secure as to development obligations. The only real gamble that the oil operator takes is whether he can recover his added investment, if any, from future recoveries.

At the time an oil operator proposes unitization, a landowner must weigh on the one hand possible future increases in oil and gas recoveries with attendant increase in revenue, as opposed, on the other hand, with revisions in his basic lease with the operator. Without too many exceptions, these revisions in the original lease are usually in favor of the oil operator. The more important of these concessions are discussed briefly.

Elimination or curtailment of drilling requirements: Many leases contain certain provisions and requirements as to rate of development. Sometimes provisions are present as to number of rigs required. Usually unit agreements will attempt to eliminate or greatly alter these requirements under the reasoning that unit operations can accomplish the same objectives without the additional drilling.

Change in lease well-spacing requirements: Many leases contain well-spacing provisions which are always revised or eliminated in any proposed unit plan.

Loss of control of unitized lands: While most leases invest operational control of the land with the oil operator, many leases do set certain standards to which the operator must conform. Competitive rate of production is one example. Offset obligations is another. Each of these requirements is minimized by unitization.

Change of lease operator: Initially a landowner granted a lease to one certain operator. Supposedly he had con-

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WHAT IT IS. FLAC* is an important new fluid loss control additive for Class A and E neat and Class A bentonite oil well cement systems. Technically, it is a high-molecular-weight, synthetic polymer. It is supplied in the form of a dry powder that is easily mixed into either cement or water.

ADVANTAGES include reliable squeezing or primary cementing—especially in porous, high temperature zones. FLAC is especially useful for permanent type and tubingless completions. Since excess cement can be reversed out before testing, this saves a round trip as well as expensive drilling-out. WOC time is held to a minimum.

WHAT IT DOES. When used in correct concentrations, FLAC drastically reduces fluid loss of the cement slurry over a wide temperature range and at high differential pressures. It is stable at both high and low temperatures and does not affect slurry and set cement adversely. Premature dehydration is prevented and the result is reliable thickening time in squeeze cementing and maximum fill-up in casing cementing.

To give some idea of just how efficiently FLAC reduces fluid loss, here are some representative figures taken from laboratory tests made under simulated well conditions.

These tests were conducted according to API procedures set forth in RP-10B, January, 1960. Slurry was first subjected to appropriate API test schedule in the pressure thickening-time tester. The time interval was equal to that required for slurry placement in a well. Then fluid loss tests were made on the slurry samples in a high-temperature, high-pressure tester. API cement filter screens were used at maximum cementing temperature and at 1,000 psi differential pressure.

Class of Cement	Percent Bentonite	Percent FLAC	Temperature (Degrees F)	API Thickening Time—Hours and Minutes	Fluid Loss at 1000 PSI cc/30 Minutes
A	0	0	113	2:30	800
A	0	1½	113	2:28	35
A	12	0	125	2:30	336
A	12	1½	125	2:40	34
E	0	0	213	1:40	1000
E	0	1	213	2:15	100
E	0	1½	213	2:50	50

AVAILABILITY of FLAC is limited until a new production plant can be put in full scale operation within a few weeks. In the meantime, operators are invited to contact Dowell for test results. In this way, they can take full advantage of material as soon as supplies become adequate. Call, write or wire the nearest Dowell office or station. Or contact Dowell, Tulsa 1, Oklahoma.

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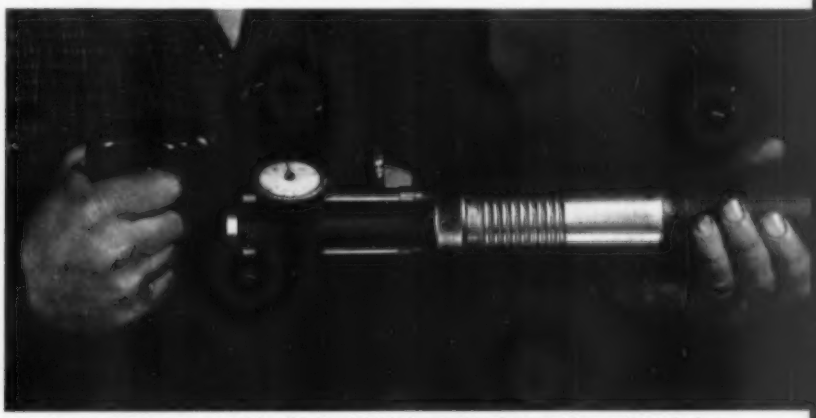
J&L GRAYLOC TUBING provides positive leak resistance at the high pressures encountered in Bright & Schiff's C. G. Joyce Well #1. Well head pressures in both zones of completion were approximately 5000 lbs. Drilling contractor, J&C Drilling Company, Corpus Christi, reported bottom hole pressures of 6300 lbs. J&L supplied 9000 feet of 2⅜-inch, J-55 Grayloc tubing, and 9400 feet of 2⅜-inch, N-80 integral joint tubing.

Independent sealing ring in each Grayloc joint provides primary sealing force.

Modified Acme-type threads provide easy stabbing, fast make-up, high resistance to damage.

Grayloc joint is machined on special facilities at J&L's Aliquippa (Pa.) Works.



Dimensional accuracy of the Grayloc joint is insured by frequent inspections during machining operations. It is available in grades J-55, N-80 and P-105.

"We used J&L Grayloc tubing because of limited clearance and high pressures encountered in this dual completion well"

. . . reports Texas driller

Producing a high pressure gas-distillate well with two tubing strings inside a 7-inch casing calls for engineering know-how and a superior tubing product. Bright & Schiff Company of Dallas, Texas, selected J&L Grayloc tubing for the job. Here's why:

Grayloc tubing, except in heavy weights, has smaller joint diameters than conventional external upset tubing. This added clearance makes the Grayloc joint especially suitable for use in multiple completion wells.

Heavy, square Grayloc threads provide easy stabbing, fast make-up and high resistance to damage. Strength of the Grayloc joint in tension exceeds that of the pipe body itself.

A separate alloy sealing ring provides the primary sealing force. The self-energized ring provides a positive, metal-to-metal seal. Grayloc joints will withstand the highest well pressures yet encountered.

For more information on Grayloc tubing, contact your nearby J&L Supply Division representative. Or write directly to Jones & Laughlin Steel Corporation, 3 Gateway Center, Pittsburgh 30, Pa.

Jones & Laughlin Steel Corporation

PITTSBURGH, PENNSYLVANIA

How one operator used D-Gassers to

reduce gas well costs by about $55,000

A Canadian operator — drilling deep gas wells in the Alberta foothills — is using the SWACO D-Gasser to save about $55,000 per well. Here is how he does it:

This operator, who was developing a gas field in the Alberta foothills, was encountering a gas-cutting problem during drilling that increased costs seriously. The problem was high-pressure, low-volume gas accumulations in a shale section above the main pay or between pay zones.

Until this shale section was reached, mud weight of 10 pounds per gallon was carried. When this section was being penetrated, however, severe gas cutting and "blowing" occurred. The gas cutting then persisted in the form of a two to three hour trip gas for the remainder of the well.

Practice before using D-Gasser

The operator circulated until he could build mud weight up to 11-13 pounds per gallon to control the gas cutting. Lost circulation in the pay section frequently occurred with the heavy mud, and a great deal of lost circulation material was often required. The cost of mud materials to control both gas and lost circulation ran $25,000 or more per well.

Initially, it took anywhere from two days to a week to condition the mud, and in one case it was necessary to set casing before drilling could proceed. In addition, several hours of rig time were lost after each trip gunning out the trip gas.

Practice when using D-Gasser

With a D-Gasser installed, the operator merely starts it up when the gas cutting occurs. Occasionally the preventers have to be closed, and the well placed on choke for a few hours. However, the whole job of mud conditioning can be accomplished in less than one day without increasing the mud weight. Moreover, penetration rates and bit life while drilling using the lower weight muds are substantially improved. Total savings in drilling costs amount to approximately $30,000 per well.

To summarize, the operator has found he saves $25,000 or more in mud costs and something like $30,000 in rig time and other drilling costs.

This case is just one of many examples that prove the SWACO D-Gasser is more than just a safety device to be used for wildcat drilling. It makes possible important reductions in overall well costs in any area where gas cutting is a problem. Contact your nearest SWACO representative to find out just how much D-Gassers can reduce your costs. Also ask him how SWACO Clayjectors and D-Sanders can further reduce drilling costs.

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fidence in this operator or he wouldn't have leased. Under unit operations this original lessee may be replaced by the unit operator. Normally this is not a serious item but it is an illustration of how a lessor loses control over an item as to which he previously had control.

Commitment of acreage without participation: This important feature alone is probably responsible for much of the negotiations required between operator and landowner. Wherever operations have a control band or area surrounding the participating unit area, the unit agreement provides for including these controlled lands within the participating boundaries after the performance of certain required actions. Prior to such inclusion the lands are committed, but meanwhile the landowner receives no compensation. If the landowner's principal asset is land from which he hopes to receive income by leasing to oil operators, commitment of his land to a unit without compensation can be a serious obstacle to his joining the unit. Lands committed to units are practically impossible to lease to any operator when he knows that if he is successful in obtaining production he must join a unit upon the unit terms.

Averaging of participation: Theoretically an operator's or landowner's participation is calculated upon some form of precise equation or formula in which the appropriate data are put in and the answer automatically cranked out. In practice, however, unit negotiations require a certain amount of "give and take" among the participants. If a landowner is fortunate to be represented by more than one operator or has more than one lease in the unit, the negotiations between operators may not affect him. It is possible, however, for him to suffer if his lessee concedes on his lease in order to balance out on another lease.

Having briefly reviewed some of the more important reasons for differences in opinion as to the merits of unitization as between operators and landowners, what steps can be taken to minimize these problems? The best advice I can offer any operator is a version of the time-honored Biblical adage — "Do unto landowners as you would have landowners do unto you." Treat them as intelligent individuals. Acknowledge that they have their own peculiar problems. Take them into your confidence early. Is it not true that the standard pattern for unitization is for the operators to negotiate among themselves first and then, after all details are settled and the pie cut up to their satisfaction, to approach the landowners and expect them to sign without question? How often are the landowners informed in detail of the plans of the operators and given the details of the expected future reservoir performance? Too often the approach is merely the attempt to sell the landowner by words among which usually are grandiose expressions of impressive increases in production.

Any landowner, whether or not he is dependent upon his lessee for his income, is certainly entitled to all the facts and data available in order that he may be able to weigh what the proposed unit plan will do to him financially. A prudent operator would be the one who would carefully analyze the landowner's problems beforehand and present the landowner with reasonable solutions at the time he proposes unitization. ★ ★ ★

IN-SITU COMBUSTION:

Large-Scale Hot Seat

Are we infringing upon the Devil's domain? Here's a light look at this burning question

MARY THOMPSON GARNER, *Tyler, Texas*

THERE HAS BEEN quite a bit of yak-yak lately around the oil fields and in petroleum periodicals about in-situ combustion. When I first heard the expression, I merely made a mental note of a rhyme for jujitsu just in case my poetry writing took a turn for the East.

However, the term kept cropping up and my native curiosity compelled me to delve deeper into the subject matter. In-situ combustion, it seems, refers to a method of oil recovery in which thick, reluctant underground oil is thinned so it can be brought to the surface. And the thinning is accomplished by heat. And the heat is derived from fire. And the fire is put thousands of feet underground by man. And I'm worried. For it looks like somebody wants to set the world on fire.

Latin Hot Seat

No wonder the process was given a Latin name. Most of us do good to understand our own language; a resurrected one is sure to leave us cold. Except in this case. This old Latin phrase may give us a hot foot. If we're standing. And we will be when we react to a universal hot seat.

You'd think things stayed hot enough for our oil men, what with foreign oil, reduced producing days, labor problems, and occasional court sessions. But now they want to play the Devil. Literally.

And I'm not so sure Satan will take too kindly to these new stokers of his furnace. He could resent their trespassing on his territory and copying his long-patented method of operation.

Of course, I know that our educated engineers, geologists, scientists, etc. have reasoned the Devil plumb out of some of his old tricks. But I'm not right sure they've reasoned me plumb out of falling for them. For instance, our learned men are convinced that volcanoes and earthquakes are sensibly and scientifically explained eruptions and rearrangings of our good earth. But I'm not convinced such strange doings aren't signs that the Devil is blowing his top and rearranging or cleaning his house—maybe making more room. And just think how upset he could get if these in-situ firebugs get to operating all over the place.

Devonian Fire Department

Now don't get me wrong. I'm all for getting that last barrel of oil from a reservoir. But it does look like our engineers could pick another way of doing it. Seems to me they may be getting into hot oil. And, really, things could stand a little cooling off instead. The in-situ guys may end up having to spread water on the troubled oils. Can't you just see a fire department answering a call to a fire at "7129 Feet Subsea."

No doubt, I'll be accused of looking at this whole thing from a feminine rather than a scientific viewpoint. It's about API for woman's engineering know-how to be rated below that of her driving skill. But I can't keep from worrying about all this playing-with-matches business. We've solved the problem of supplying oil for the lamps of China—now we want to light them.

One thing about in-situ combustion —the petroleum industry couldn't have picked a more auspicious time for working with such a process. If the world does get blown up, most of the inhabitants will go to their cremation blaming it on the scientists and their atom bombs. But as I go up in smoke, I'll probably be yelling "I told you so" to the petroleum engineers. ★ ★ ★

EXPLORATION ACTIVITIES

ALASKA

Company Moving In Rig For 4th Test in Yakutat

Drilling equipment is being moved onto location for a fourth exploratory well on a 1,100,000-acre leasehold in the Yakutat area of southeastern Alaska. Colorado Oil and Gas Corporation holds the oil and gas leases jointly with Continental Oil Company and Frankfort Oil Company.

Promising oil and gas shows have been found in three previous test wells. Latest well, projected to 11,000 ft, will be 15 miles southeast of Yakutat.

TEXAS

Dual Gas-Oil Producer Hit in DeWitt County

A dual gas-oil producer has been made in the Doehrman field in DeWitt County, Texas, by Jade Oil Company and Tennessee Gas Transmission Company.

The number 3 W. O. Drier Unit is located three miles southeast of Meyerville and represents the first oil production in the area.

Oil discovery was made in the First Massive Wilcox and perforated at 8172 to 8178 ft. On an eight-hour test, the well was credited with a flow rate of 245 bbl of oil per day through an 11/64 in. choke. Flowing tubing pressure was 1100 lb.

Through perforations at 8094 to 8104 ft in the Mac Hank Sand, the upper side of the well flowed gas at about 1,000,000 cu ft per day through an 8/64 in. choke on initial test.

Jade Oil and Associates have a half interest in the well. Remaining half interest is held by Tennessee Gas, which is the operator.

ALGERIA

Three Companies Agree To Prospect Tan Emellel

An agreement for the joint exploration of oil concessions in the Sahara has been concluded by three companies.

Gewerkschaft Elwerath, Societe de Recherches et d'Exploitation de Petrole Eurafrep and Societe de Participations Petrolieres (Petropar) have agreed to prospect the concession Tan Emellel west of the Edjeleh oil field. The concession was granted to Eurafrep last year.

It pertains also to the Hassi Ali concession near El Golea, which the group has applied for.

Interests held by the three companies in the Tan Emellel concession are Eurafrep 70 percent; Gewerkschaft Elwerath 20 percent; and Petropar 10 percent. Participation in the larger area, Hassi Ali, is 42.5 percent each for Eurafrep and Elwerath, and 15 percent for Petropar.

Eurafrep will act as operator in both concessions and will thus be in charge of prospecting operations. In the event of further concession being granted to the group at a later stage, Gewerkschaft Elwerath will probably be appointed operator.

ATLANTIC COAST

Companies Request Permits To Explore Coastal Waters

Applications have been received from oil companies for authorization for permits to conduct geological and geophysical explorations on Outer Continental Shelf off Atlantic Coast, U. S. Department of Interior has announced.

Appropriate notice will be published in the Federal Register in the form of a general authorization.

U. S. Geological Survey has advised Secretary of Interior that although no commercial oil and gas deposits have been discovered along the Atlantic Coast, possibilities of finding oil and gas increase in a seaward direction because of an increasing thickness of sedimentary formations in an easterly direction. Water depths are relatively shallow and exploratory drilling is technologically possible up to 75 miles offshore.

AUSTRALIA

20,000,000-Acre Permit Granted in Amedeus Basin

Magellan Petroleum Corporation, representing U. S. interests, has been granted petroleum permits on 5,000,000 acres in Amedeus Basin of Australia's Northern Territory, bringing company's total holdings in country to more than 20,000,000 acres. Magellan also has applications pending on an additional 1,400,000 acres in this area.

Geological crews presently are being assembled at Alice Springs to begin field mapping and surface studies of newly-acquired properties, which are administered by Australian Federal Government.

Magellan has now completed aerial magnetometer and gravity surveys of large portions of company's permit areas in Great Artesian Basin of Queensland, and recently completed drilling a 4500-ft stratigraphic test on properties in Queensland's Win-Ton area.

CANADA

10,720 Acres Acquired In Trans-Canada Export Area

In first purchase since its $10 million sale this spring, Britalta Petroleums Ltd. acquired 10,720 acres in petroleum and natural gas reservation rights in the Trans Canada export area of Medicine Hat field. Price of purchase, made at Canadian provincial land, oil, and gas sale was $235,000. Britalta plans to drill immediately to evaluate their new leases.

COLOMBIA

Wildcat Well Flows Oil In Magdelena Valley

Sinclair Colombian Oil Company, Inc. has discovered oil in its Santos No. 1 well, a wildcat located in the middle Magdelena Valley of Republic of Colombia.

Well flowed 37 gravity oil in a drill stem test of one zone. Additional zones are being tested.

Well is owned jointly by Sinclair Colombian Oil Company, Inc., operator, and International Petroleum (Colombia) Ltd., and it is on a tract totaling 215,060 acres.

COLORADO

Well in Adams County Flows 333 Bbl Per Day

An oil discovery in West Adena area, Adams County, Colorado, was perforated from 6294 to 6309 ft in Dakota sand and flowed at a rate of 333 bbl per day on a 15/32-in. choke during a 6-hr test. Owned by Delhi-Taylor Oil Corporation, well is designated Cowell Number 1.

Delhi has a 100% working interest in 7700 acres in this area, and will earn additional acreage as other wells are drilled.

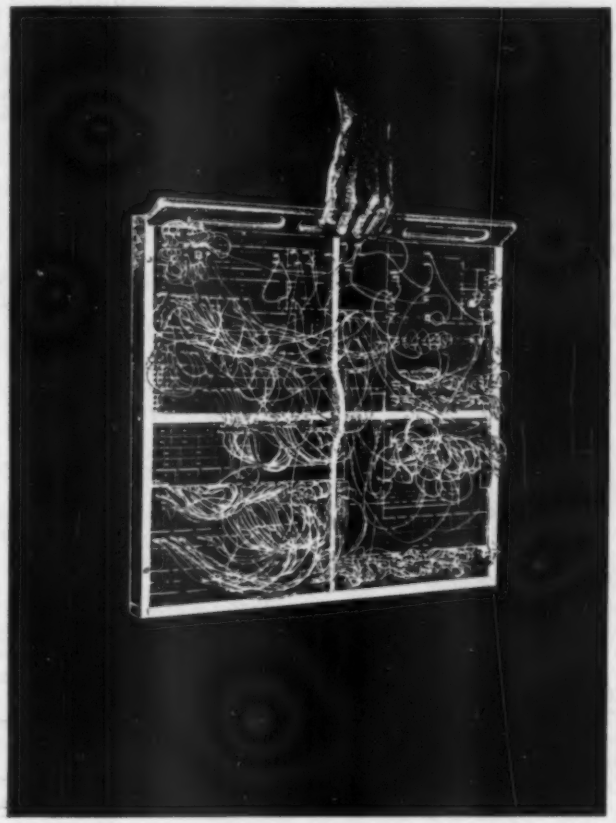
GREECE

Exploration Planned In Aetolia-Akarnania

British Petroleum Exploration Company (Greece), in partnership with the National Bank of Greece, has signed an agreement for oil prospecting and exploitation rights over a land area of about 2000 sq miles in province of Aetolia-Akarnania and islands of Lefkas and Cephalonia in Western Greece.

BP and National Bank have jointly formed Aetolian Oil Company, S. A. to hold concession, and operations will be conducted by BP Exploration Company (Greece) Ltd.

Under agreement, exploration rights



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last for eight years, when a development concession must be taken out. This concession would be for 30 years, with a possible renewal for an additional 10 years.

IRAN

Test Well Spudded In Pazanun Area

Iranian Oil Exploration and Producing Company spudded in a new test well in the Pazanun area, following its program of exploration drilling in the Agreement Area.

Pazanun is situated along the Agha Jari-Behbahan road, 18 miles southeast of Agha Jari.

First exploratory well was drilled in 1926. Thus far, four wells have been drilled, but none proved successful in finding oil.

It is expected to take four or five months before any results, positive or negative, can be expected of the new Pazanun test well No. 5, the company states.

KANSAS

Well Flows 490 Bbl Per Day In Southeast Eubank Field

Helmerich & Payne, Inc. of Tulsa has released results of state potential test taken on new zone discovery oil well, Reimer No. A-1 in Southeast Eubank field of Haskell County, Kansas. In the test, well flowed at a rate of 490 bbl per day through a ¾-in. choke from Marmaton section between 4674 to 4692 ft. Well's location is C SW SW Section 35-28S-34W and it is ½ mile southwest of pool's first well, which was a Lansing zone oil discovery.

Reimer No. A-1 was drilled to a total depth of 5634 ft in St. Louis formation of Mississippian age and was plugged back to Marmaton pay zone. A 4½-in. casing was set at 4745 ft and perforated from 4674 to 4680 ft in Marmaton with two holes per ft. After acidizing with 500 gal, well flowed at a rate of 29 bbl per hr on production test.

Discovery in Morrow Sand Flows 342 Bbl Per Day

An oil discovery in Haskell County, Southwest Kansas, has been dually completed with an oil flow of 342 bbl a day from Morrow horizon at 5280 ft and 175 bbl daily from Chester horizon at 5380 ft.

Walton 1 well, owned by United Producing Company, should have a total allowable production rate of 130 bbl daily. Confirmation well is drilling ahead at 2112 ft on United's 86,000-acre lease block.

Two Morrow producing zones totaled about 21 ft in thickness but Chester section had overall thickness of about 60 ft with 40 ft being saturated. Test made while drilling indicates upper portion of Chester section may be gas saturated.

Closest Morrow and Chester production is 5 miles north and 2.5 miles south of well, and there is no close development east or west of intervening acreage. Well was drilled as a result of a detailed seismic survey below regular Hugoton producing zone.

LIBYA

Two Deep Test Wells Begun In Cyrenaica and Benghazi

British Petroleum Exploration Company (Libya) has started drilling two new deep test wells in Libya. These are well No. Bl-34, located about 75 miles south of Tripoli, and well Al-80 which is in Province of Cyrenaica about 325 miles south-southeast of Benghazi.

Drilling also continues on well Al-35 about 80 miles east of Benghazi and it is now down to more than 8000 ft.

In addition, seven seismic parties are working in various BP concessions and light mobile rigs are being used to drill water and shallow geological information holes.

Operational headquarters of BP Exploration in Libya are in Benghazi.

OFFSHORE LOUISIANA

Well Pay Section Holds Ten Sands In 202 Ft

Gulf Oil Corporation has drilled 202 ft of pay sand in its offshore well on Block 151, OCS 0463, about 30 miles off Louisiana in South Timbalier Bay area. Pay section was found in ten sands from 8300 to 12,300 ft and total measured depth of well is 12,339 ft.

Test results have not been released.

Great thickness of pay section of D-5 well, which is a southwest outpost well on south flank of giant salt dome in Block 135 field, should assure Gulf of major reserves in field. Company's leases on salt dome total 22,500 acres in which Gulf owns 100% working interest.

Another Gulf well, D-4, was drilled about a mile northeast of D-5 and had a total of 91 ft of net oil sand between 9600 and 10,950 ft. It was completed as a triple oil well.

Additional development drilling will be required to prove both vertical and lateral extent of new production.

NEBRASKA

Discovery Oil Well Flows In Laverchek Field

Ambassador Oil Corporation of Fort Worth, Texas has made a discovery oil well in J sandstone of Banner County, Nebraska, about three miles southeast of the town of Harrisburg.

Well is Ambassador No. 1 H. L. Snyder, which is located in CNW NE Section 17, Township 18N, Range 55W. It is south of Harrisburg field and northeast of Laverchek field.

Discovery, which was drilled to total depth of 6118 ft, is producing from perforations at intervals of 6040 to 6044 ft, 6046 to 6051 ft, and 6058 to 6062 ft. At 6118 ft, 5½-in. casing was set. Top of J sand was encountered at 6038 ft.

Well pumped 120 bbl of oil and 15% basic sediment and water in 24 hours after being treated with mud acid and sand fractured.

Ambassador has a 69% working interest in 1280-acre block on which discovery was drilled.

NEW MEXICO

Important Wildcat Well Flows 1224 Bbl Per Day

Union Oil Company of California completed a wildcat discovery flowing high quality 40 gravity crude oil at rate of 1224 bbl per day through a 30/64-in. choke and 800-lb tubing pressure.

Well, drilled on 360-acre unit of North Anderson Ranch prospect in Lea County, New Mexico, was completed in Wolfcamp zone with perforations at 9952 to 9980 ft.

Union holds a 22% interest in the unit, and plans to drill a well offsetting the discovery on 680 acres in the immediate area owned entirely by the company.

Gas Condensate Well Flows 545,000,000 CFD

Dual completion of a large exploratory gas condensate well in North Eddy County, New Mexico, gave an absolute open flow potential of 545 million cu ft of natural gas per day.

The Ohio Oil Company well, No. 1 Andrew Arnquist-State, is six miles south of Artesia, New Mexico, and a half mile northwest of Ohio's No. 1 Nix, which opened production from the new well's producing formation in the area.

Production is through perforations between 9060 and 9084 ft, and 9092 and 9120 ft in the bend section of the Pennsylvanian formation. No. 1 Nix flowed at the rate of 11,100,000 cu ft daily.

OHIO

Biggest Producing Gas Well In Area Hit at 3226 Ft

A gas well producing 5,000,000 cu ft was brought in on old Route 83, Monroe Township near Conneaut, Ohio. Strike was made at a depth of 3226 ft. One of biggest producers in the area, well was drilled by Peter and Joseph Flanagan of Bradford, Pennsyl-

vania for themselves and associates.

Gas will be acquired by East Ohio Gas Company. A dozen other gas wells drilled in area this year produced a flow of 150,000 to 200,000 cu ft each.

TEXAS

Group Plans Handling Shell Offshore Operations

Shell Oil Company has formed a new production group to handle offshore operations in Texas.

F. D. Leigh, former production superintendent of Shell's New Orleans area marine production division has been named manager of the new group.

Largest single holder of leases offshore from Texas, Shell has 134,482 acres under lease, including 126,720 in federal zone and 7762 in state zone that extends 10.5 miles from shore.

Farthest West Gas Well Hit Near Guadalupe Peak

Mobil Oil Company has completed a new gas well farther west in Texas than any current producing well within sight of the highest point in Texas. Production has been established at Socony Mobil Oil's No. 1 State-Barrett which flowed 25,800,000 cu ft of gas from perforations in Pennsylvanian-Strawn section at 5878 to 5887 ft. Operator was unable to shut off a flow of sulfur water, however, and a plug was set and pipe perforated at 5814 to 5829 and 5843 to 5857 ft, where well had calculated open flow of 13,500,000 cu ft of dry gas a day.

Location is northeast of section 18, block 63, township 2 of T&P Survey in Culberson County. It is 30 miles west of nearest production of any kind in Delaware Basin and is within sight of Guadalupe Peak on the Texas-New Mexico state line.

Mobil has leases on about 60,000 acres of Jax Cowden and Fred Barrett ranches, with TXL Oil Corporation holding alternate sections in block. Strike may open an entirely new field in the area.

Well was drilled tight to a total depth of 9578 ft, and plugged back to 7143 ft.

Plans are already underway to drill a second well in area.

VENEZUELA

Drilling Operations Resumed On El Roble Concession

Drilling operations are being resumed by Phillips Petroleum Company and Pantepec Oil Company, C. A. on their jointly held 18,000 acre El Roble concession in the eastern state of Anzoategui.

Development drilling to tap the prolific Merecure sands of the El Roble structure was discontinued about seven years ago by the Venezuelan Ministry of Mines and Hydrocarbons as a gas conservation measure. Phillips Petroleum, operator of the Phillips-Pantepec property, recently obtained government approval of a plan for gas conservation, reopening the area for development.

The El Roble area comprises a 30,000-acre structure owned about 50% each by Creole Petroleum and Phillips-Pantepec. Phillips acquired its interest in the property from Pantepec in 1956 under an agreement in which the latter company reserved certain net profits in Merecure production.

Merecure discovery well, Creole RCN-15, drilled at El Roble in November 1948, was completed as a 600-bbl-per-day dual-zone producer in these sands. Production of Merecure's high-gravity oil, nearly 49 deg API, is accompanied by unusually high GOR.

PERSIAN GULF

Oil From Wildcat Tested Near Qatar Peninsula

Shell Oil Company of Qatar is testing oil found in Middle Jurassic formation of a wildcat being drilled 52 miles east of Qatar peninsula.

Pending results of testing, company gave no details. New well, Idd El Shargi No. 2, was spudded earlier this year with a new Netherlands-built mobile platform called the Seashell.

Only SPANG can give you the best in Strength, Service, Economy and Footage in a Prosser-type SWIVEL ROPE SOCKET

There are times when an ordinary rope socket will meet your needs. But there are too many times when you can't afford to risk trouble—when you require a rope socket that's precision made and utterly dependable under all conditions. This is the time you'll be glad to have a Spang Rope Socket on the business end of your string—

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It's New

Drilling – Producing Equipment

Double Wall Drill Pipe

Flexweight drill stem member is a two-tube or double wall drill pipe designed for use above a short drill collar since the pipe furnishes additional weight.

Special pipe permits use of high optimum bit weight without handling problems, maintenance costs, and fishing hazards of a long drill collar string, manufacturer states.

In the pipe, a special alloy steel tube is fitted to inside of internal upset drill pipe. Annular space between tubes is filled with a viscous tar. Inner tube is one in. smaller OD than outer pipe and is the same weight per ft as drill pipe of that size.

All types of shrink, flashwelded and counterbore welded tool joints can be used on drill pipe, and the pipe is available in many sizes. A 30 ft joint of 4½-in. OD double-wall pipe weighs just over 1000 lb.

Advantages claimed are shorter trip time due to ease of handling, better penetration rates and longer "up-hole" pipe life because of vibration damping of viscous tar-packed annulus, and the safety which is provided by a small flange at upper end of inner tube which is sufficient to retrieve lower portion of drill stem in event of an outer pipe twist-off as it nears end of life. *Flexweight, Inc.*

Circle number (1) on reply card.

Sound Velocity Logs

Sound velocity logs which record simultaneously a 1-ft spaced curve, a 3-ft spaced curve, and either a self potential or a gamma ray curve, are offered by Lane-Wells.

Called Dual Spaced Acoustilog, service is used in evaluating porosity in massive sandstones and carbonate formations. Device offers exclusive feature of recording both 1 and 3-ft spacing simultaneously with either self-potential or gamma ray curve. *Lane-Wells Company.*

Circle number (2) on reply card.

Triplex Plunger Pumps

Two new triplex plunger pumps are offered by Gardner-Denver for waterfloods and salt water disposal.

PQ-215 hp pump has a 2-in. stroke and can be equipped with plungers from 1 to 2¼-in. diam. This provides maximum working pressures from 425 to 2140 psi and deliveries of 175 to 1770 bbl per day. Weight of bare PQ-2 pump is 570 lb.

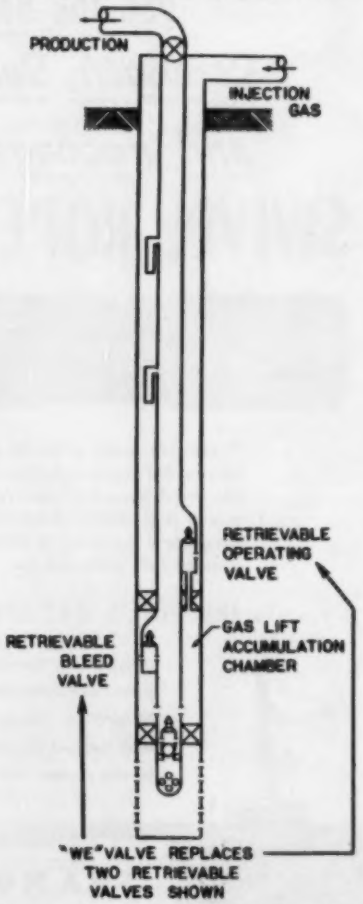
PQ-25 30 hp pump has a 2½-in. stroke. It can be equipped with plungers from 1 to 2¾-in. diam, to provide maximum pressures from 450 to 2200 psi. Capacity ranges from 348 to 3300 bbl per day, depending upon plunger size and speed of operation. Bare PQ-25 weighs 720 lb. *Gardner-Denver Company.*

Circle number (3) on reply card.

Gas Lift Valve

Rapid venting of accumulation chambers in gas lift wells through a half-inch vent port and positive regular gas lift valving through its 11/16-in. main port is now possible with new Harold Brown type WE wire line gas lift valve that does two jobs at the same time.

Valve does work of vent valve and lower gas lift valve in standard accumulator chamber installations, and it is designed particularly for high GOR wells. Valve is used in side pocket mandrels, and existing accumulation chamber installations can be converted to WE by retrieving lower gas lift valve and replacing it. Existing vent valve would not need to be removed. *Harold Brown Company.*



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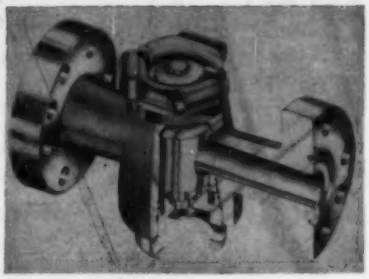


Flanged End Plug Valves

Lo-Torq plug valves with flanged ends have been designed by Halliburton and are available in a variety of sizes. Standard-threaded low torque valves have been on market over a year. Valves are named after one of their primary features, low torque.

Valves are used on flow lines, separators, Christmas trees, casing heads, tubing heads, swabbing and servicing operations. Plug and inserts which are subject to most wear may be replaced without removing valve from manifold or line. *Halliburton Company.*

Circle number (5) on reply card.

Gas-Condensate Unit

New gas-condensate production unit is available from National Tank. Called the Thermosiphon Stak-Pak, new pre-piped, skid-mounted unit combines any National two or three-phase horizontal separator with any size indirect heater.

Design features include a flame arrestor, which permits grouping a heater and a separator on same skid with automatic instrumentation. Device also has a thermosiphon feature which places heat-on-demand in base of separator, non-freeze type liquid valves, and liquid level controls with sight glasses.

Separators are code constructed and stamped with code required valves and safety heads. *National Tank Company.*

Circle number (6) on reply card.

Well Servicing Unit

Wilson Winchmobile Junior has a double drum winch, 66-ft fabricated angle steel mast with 120,000 lb capacity. It has a cross-mounted diesel engine for power.

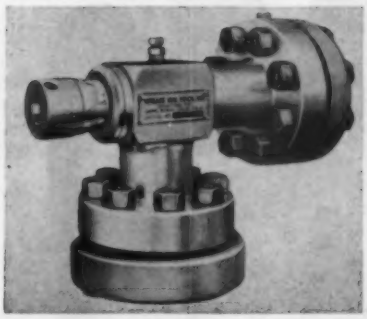
Weight on front axles amounts to 16,190 lb; rear axles, 28,810 lb; and a gross weight of 45,000 lb. Rated capacity is 8000 ft of 2½-in. upset tubing. Unit has a total length of 42 ft 5 in., and a height of 11 ft 6 in.

Special crown makes blocks fall with flat side toward mast. Unit has guy line winches, automatically-raised racking platform, air-tube disc clutches on all drives.

Line-raised mast has a two-point base and outriggers. It also has 38,000-lb capacity dual rear axles and 18,000-lb capacity dual front axles, both with power steering and large-size heavy-duty tires.

Frame is truss-type angle steel fabricated for great strength but is light weight. *Wilson Manufacturing Company.*

Circle number (7) on reply card.



Injection Valve For Multiple Orifices

Willis Multiple Orifice Injection Valve has exceptionally low adjustment torque at very high pressures and meters fluids from a minute flow to full line flow with less than a one-quarter turn of stem. Valve has micro-fine adjustments and its non-corrosive metering discs are capable of withstanding extremely corrosive fluids. *Willis Oil Tool Company.*

Circle number (8) on reply card.

Non-Acid Chemicals To Disperse Mud

Two non-acid mud-dispersing chemicals, Mud-Flush and Howco Oilsperse, have been introduced by Halliburton. Designed to improve well completions, including primary cementing jobs, chemical should help remove fluid mud in well bore and mud lost to fractured or vugular formations.

Mud-Flush is aqueous solution of several additives designed to remove water-base drilling fluids from various producing formations by lowering viscosity of mud and maintaining solids in dispersed state.

Howco Oilsperse is an oil-base solution designed to serve as a buffer during primary cementing jobs and it helps prevent oil-base and oil-external emulsion muds from contaminating cement. *Halliburton Oil Well Cementing Company.*

Circle number (9) on reply card.

Compact Pressure Regulators

Grove Valve and Regulator is marketing a line of compact, lightweight pressure regulators which are designed to handle a broad range of pressures. Regulators are available for pressure reducing, back pressure, and a combination of pressure-reducing and relief service.

Pressure-reducing models, produced in sizes ranging from ¼ through ½-in., can be used for inlet pressures as high as 10,000 psi and adjustable-controlled pressures up to 6000 psi. Combination pressure reducing and relief regulators are designed for inlet pressures ranging up to 6000 psi and are available in sizes of ¼ through 1-in. Back pressure models will accommodate pressures up to 3000 psi and are available in ¼-in. sizes.

Regulators are of gas-controlled dome type, operating on principle of balanced pressure with valve action controlled by pressure reaction chamber. Restricting orifice connecting chamber with dome governs rate of pressure equalization. *Grove Valve and Regulator Company.*

Circle number (10) on reply card.

Two-Zone Subsurface Pump

New D plus B two-zone subsurface pump featuring an upper-pump standing valve has been introduced by Continental-Emsco Company. Patented valve, which consists of drop and seat, gives multi-zone pump same operating efficiency of any standard pump, plus operating flexibility required in multiple-zone completions.

Design of valve enables retrieving pump on sucker rod string. Valve attached immediately below upper-pump barrel provides closest valve spacing possible for maximum compression on down-stroke. Carbide material sealing surfaces resist corrosion, sand, and fluid cuttings.

Available two-zone pump types are two packer; one packer with hollow sucker tubes; one packer parallel installations with either two or three tubing strings; triple completions, two or three packer. Two packer and one packer with hollow sucker rods come in 4½ to 7-in. OD casing sizes, others in 5½ to 7-in. *Continental-Emsco Company.*

Circle number (11) on reply card.

NOW!

PIPE AND TUBULAR GOODS INSPECTED IN EUROPEAN MILLS BY UNIVERSAL ENGINEERING CO.

Purchasers of pipe and tubular goods from European mills can now have accurate technical representation at the mill through Universal Engineering Co.

Two services are available:

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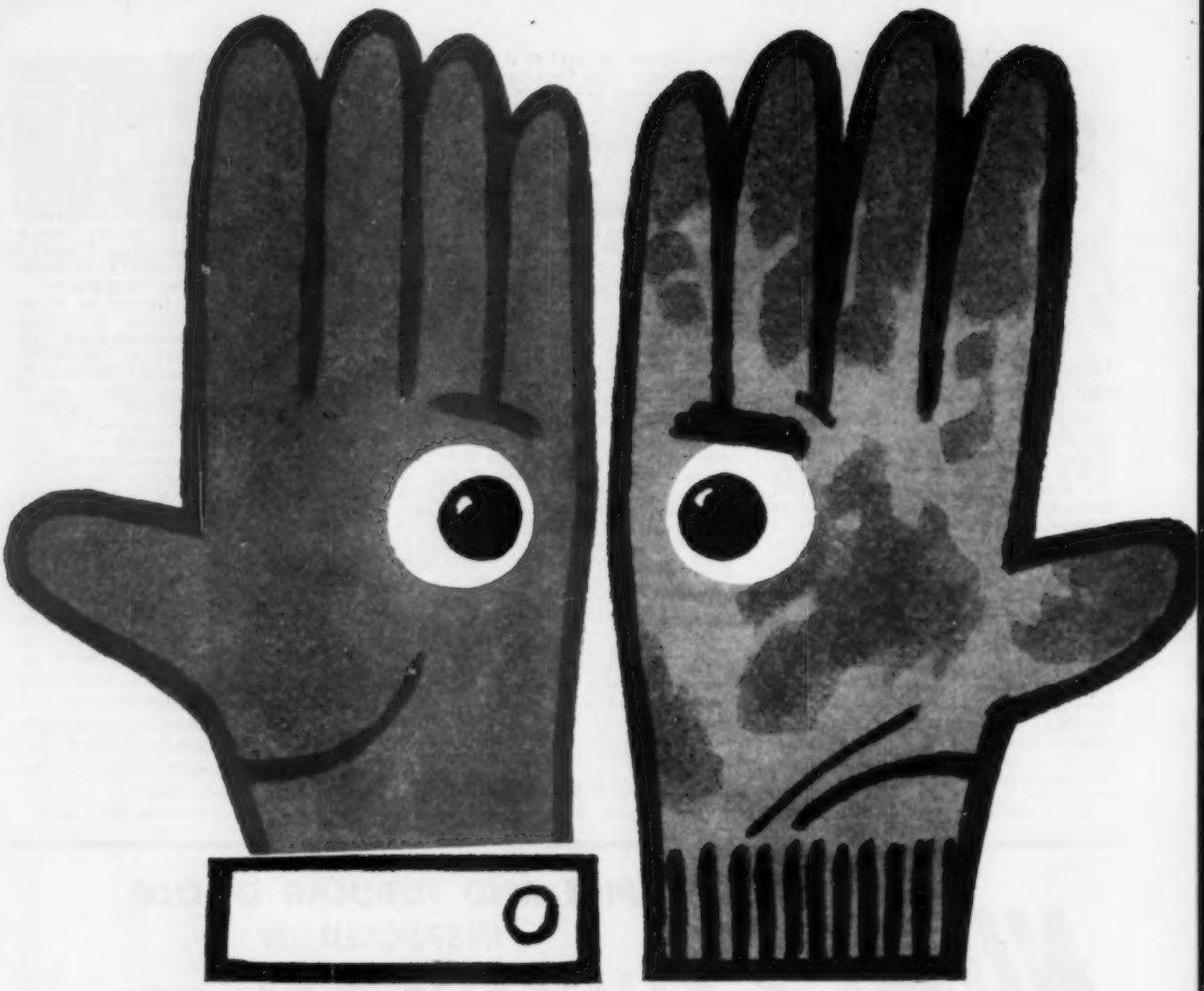

Does the right hand know what the left hand is buying?

Many times in mud buying the smiling left hand is happy because it is concerned only with the mud bill. And that can be kept low. But, a low mud bill often means low drilling efficiency. And that makes the right hand unhappy because it is concerned with keeping the *total* drilling operation efficient and economical.

An inadequate mud system can be responsible for a great deal of unnecessary expense in drilling an oil well. It can cause extra round trips, more bits. It can mean a slower rate of penetration, and time wasted in conditioning the mud. Poor mud can even damage the productive zone.

If these things happen on your wells with a fair degree of consistency, why not review the way "your hands" buy drilling mud. A well planned Magcobar mud program *may* cost a little more than a *cheap* mud program (although it will likely cost even less), but it can and will reduce your over-all drilling cost. It may even help you increase your production!

A *cheap* mud program may be the most expensive single item on your wells. A Magcobar planned mud program, on the other hand, assures the right use of the right products, makes full use of the money-saving advantages of Magcobar Technology. So, why not get all of your hands working towards the same objective? Let Magcobar plan with you to get the best wells at the lowest *total* cost.

Magcobar
Complete
DRILLING MUD SERVICE

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OIL • GAS • CHEMICAL
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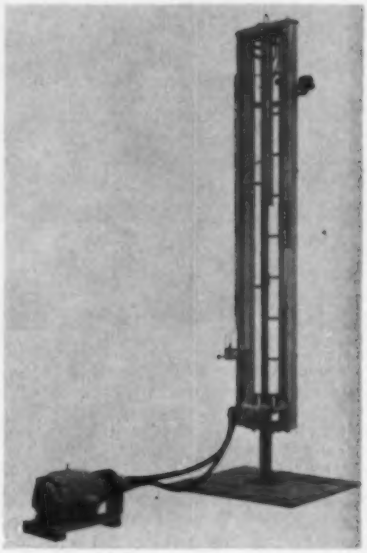
WELL DONE WITH MAGCOBAR TECHNOLOGY • MAGNET COVE BARIUM CORPORATION



Surface Hydraulic Pump

Surface hydraulic pumping unit has been developed, field tested, and it is now available through Axelson Division of U. S. Industries, Inc.

Introduction of 36-in. stroke unit follows 24-in. unit made available to operators a year ago.

The 36-in. unit is available in two polished-rod load capacities, 3500 and 5000 lb. Both units are complete, including a direct drive electric motor or a vee-belt drive for internal combustion engines. Various power-package combinations are available with different-size power pumps for obtaining cycle rates suitable for varied pumping conditions.

Unit will produce wells from stripper category to those requiring over 100 bbl per day, depending on depth and pump bore. *Axelson Division.*

Circle number (12) on reply card.

Pump Pistons, Rubbers

Complete line of pump pistons and replacement rubbers designed for service with water-base drilling fluids has been announced by Guiberson.

Type-designated as regular, rubbers are interchangeable on one-piece forged-steel piston hub, which need not be removed from the rod when rubbers are replaced. Rubbers are available with 2½-in. ID to fit 3¾ to 4½-in. liners; 3-in. ID to fit 4½ to 7-in. liners; or with 3¾-in. ID to fit ¼ to 8-in. liners. Hubs are available in all popular API tapers. *Guiberson Corporation.*

Circle number (13) on reply card.

Steel Buildings

Armco has introduced a completely new line of pre-engineered steel buildings. Clear-span widths are reported to range from 5 ft 4 in. to 120 ft, and sidewalls up to 40 ft. There is a whole new series of buildings with a single slope roof and in widths up to 24 ft.

Choice of roof slopes is offered in self-framing and rigid-frame buildings from 8 to 120-ft wide. Option is available between low silhouette roof, 2 to 12 pitch, or the traditional 4 to 12 pitch. Single-slope roof offers more variety, starting with a nearly flat roof design. *Armco Drainage & Metal Products, Inc.*

Circle number (14) on reply card.

Its mirror-smooth interior walls enable KRALOY PVC PIPE to deliver 20% greater volume.

STOP SOUR CRUDE CORROSION, SCALING, PARAFFIN BUILDUP WITH KRALOY PVC PLASTIC PIPE

Sour crude troubles and tough oil piping problems are today being handled quickly, easily and economically by intelligent application of corrosion-proof KRALOY PVC PLASTIC PIPE. Moisture, rust, rot and gunk don't faze KRALOY. In gathering lines and salt water disposal lines, for example, oil operators and engineers find that KRALOY'S unique qualities handle the job as no pipe of other material can. Amazingly light (⅛ the weight of steel), KRALOY'S high impact rating and flexural strength simplify transportation, handling and laying. Add the ease of cutting and joining KRALOY, you can then save up to 50% in installation costs!

Immune to electrolytic action and sulfate chemicals, KRALOY defies iron oxide salt deposits, resists scaling and paraffin buildup. Inert, corrosion-proof, it remains impervious to soil and most common acids—*never needs painting or cathodic protection*—cuts repairs and maintenance costs to the absolute minimum. Precision extruded, with mirror-smooth walls for maximum line-flow, KRALOY delivers up to 20% greater volume than same-size pipe of other material. Continuous rigid laboratory control insures unchanging KRALOY quality and long life of service. Available in all sizes from ¼" to 12" with plastic valves and fittings; also as U/L listed* electrical conduit in sizes ½" to 6".

*For direct underground burial, or encased in concrete.

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Water Conditioner

Improved Karlson scale remover water conditioner finds use in water flooding, well heating, and motor cooling. It removes lime scale, rust, silica deposits, algae and slime. Conditioned water won't harm metal equipment.

Chemical remover used in the conditioner is a solid crystalline material containing excess elemental hydrogen and wetting agents readily dissolvable in concentrations normally required for heat exchange equipment. *G. W. Galloway Company.*

Circle number (15) on reply card.

Engine Analyser

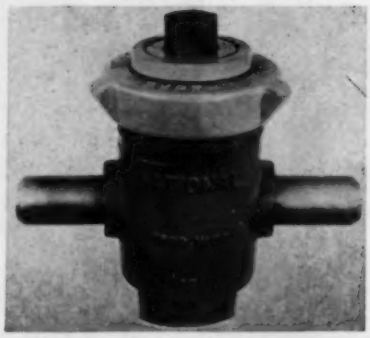
The Baird-Atomic Direct Reader, a spectrochemical instrument, performs an oil analysis to reveal engine condition. Device analyses metal elements or alloys present in the oil to determine whether abnormal wear of particular parts has occurred. Contamination can be revealed by measuring other elements which may be present in the oil, and also fuel dilution or carbon.

Special suction gun which is inserted into the dip stick tube secures a sample which is sent to the company's laboratory for analysis. *Baird-Atomic Spectrochemical Department.*

Circle number (16) on reply card.

Simple Tubing Head

Development of a simpler tubing head for medium and shallow wells, where completion and production methods do not require a more complex assembly,



has been announced by National Supply.

Known as Type K Tubing Head, it has a full opening bore and is available with female casing connections of 5½ in. and smaller. Type K can also be provided with a 7-in. male casing connection, which has a 5⅛-in. body-through bore.

Optional thread or slip suspension for 2⅜ or 2⅞-in. OD tubing is obtained with interchangeable mandrel hangers and slip packing units. Slip packing unit is identical to that used in Type E Tubing Head.

Standard accessories include elements to permit use of Type E Stripper with Type K Tubing Head. *National Supply Company.*

Circle number (17) on reply card.

Circulating Packer

Circulating packer is now being manufactured by Page Oil Tools. It is a hookwall type with a built-in sleeve valve which permits circulation of the fluid in casing annulus when packer is set.

Valve in VP Packer is opened and closed with wire line tools. When it is in open position, circulation is made in either direction through inside of packer element. Packer can be set by conventional top hole manipulation and applying a portion of tubing weight to compress packing element.

Packer is adaptable to such permanent completion practices as perforating casing below tubing string and running a retrievable tubing extension to provide circulation to bottom. Packer is available in most popular casing and tubing sizes. *Page Oil Tools.*

Circle number (18) on reply card.

Roller Reconditions Casing

Bowen Casing Roller is specifically designed for reconditioning casing, and it does not contain any small parts to be worn, broken or lost in the well. All moving parts are held in place on the eccentric mandrel by large ball bearings running in deep grooves in the mandrel and tapered nose.

Roller is used to recondition and restore well casings to their normal internal diameter and roundness. It is designed to enter into smallest ID of collapsed, buckled, or dented casing, and as it is forced downward exerts lateral pressure on casing to restore normal ID.

Roller consists of eccentric mandrel upon which are mounted a series of rollers and a tapered nose cone. Upper end of mandrel is fitted with threaded box connection for connection to drill pipe. Tapered nose cone locks all rollers in place on mandrel by large ball bearings running in deep grooves in mandrel and nose cone.

Design permits use of interchangeable rollers on each size mandrel. *Bowen Itco, Inc.*

Circle number (19) on reply card.

Model KCA Triplex Reciprocating pump, made by the Worthington Corp., Harrison, N. J.

WISCONSIN-POWERED salt water pump

MODEL VG4D
4-cylinder —
25 to 37 hp

Once started, this Worthington salt water disposal pump becomes an automaton. It works 24 hours a day, every day. To keep up the pace, the pump is powered by a heavy-duty air-cooled Wisconsin Engine that is tailored for the grueling job.

The rugged VG4D Wisconsin is built to stand up under continuous loads. It is precision-fitted to cut wear and upkeep. Its high torque enables the engine to slug through shock loads without stalling.

The air-cooled Wisconsin starts fast and runs smoothly in freezing cold and broiling heat. And you don't have to bother with water or anti-freeze — nor with radiators, water pumps, fan belts, and other water-cooling parts.

For the most power service with the least care, specify Wisconsin Engines on your utility units. Get Bulletin S-249 covering all Wisconsin Engines — 3 to 56 hp.

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Oil Well Cementing

PART II

Slurry Design

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BJ Service offers you the answers to your Cement Slurry Problems!*

Here is a new BJ Service Technical Bulletin on cementing—*the first study of its kind ever published!* Organized to eliminate hours of research and involved calculations, it provides a rapid, efficient comparison of most cement slurries on the basis of yield, weight, volume, thickening time, strength, cost and other important factors.

Assuming a knowledge of any particular well, this Bulletin shows engineering or field personnel how to design a slurry for that well... contains a wealth of other valuable, concentrated reference material that cannot be duplicated from any other source.

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PARTIAL TABLE OF CONTENTS

- Correct use of admixes
- The Design of slurries
- Control of slurry properties
- Survey of portland cements

"Slurry Design," is a companion bulletin to "Principles and Practices of Oil Well Cementing," recently published by BJ Service.

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NOTE: If you would also like a copy of Part I, "Principles and Practices of Oil Well Cementing," please check here. ☐

39 BHP Gas Engine

Allis-Chalmers has expanded its line of gasoline and natural gas engines with the addition of the G-138, a new 4-cycle, 4-cylinder, 138 cu in. piston displacement unit that develops 39 brake hp at 1800 rpm.

New engine is a companion to the G-149 and G-226 engines and has been designed, engineered and is being built by the company. Unit is 46 in. long, 18 15/16 in. wide, and 30½ in. high to the top of the radiator, making it a compact unit. *Allis-Chalmers Manufacturing Company.*

Circle number (20) on reply card.

High Pressure Gate Valve

Jerome No. 648 gate valve is now available for applications where high pressure liquids and gases, and high vacuum in the micronic range are encountered.

Solid wedge, inside-screw gate valve with bolted bonnet for close quarters is precision-machined and responds to finger-tip control even under high pressure. Special O ring seals will not dry out under vacuum, manufacturer states. *Jerome Hydraulics Company, Inc.*

Circle number (21) on reply card.

Drill Collar Designed To Reduce Hole-Sticking

Different design of drill collar has been developed by Engineering Enterprises. Collar is expressly designed to reduce sticking of collar string due to differential pressure forces.

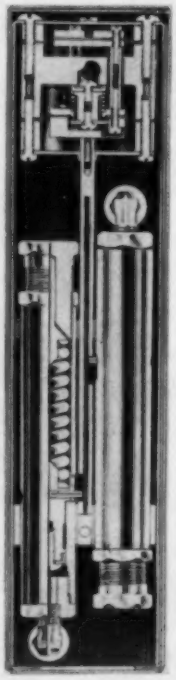
Effective reduction of forces is accomplished by decreasing 40 percent of total contact area of drill collar body and wall of bore hole. Drilling mud hydrostatic pressure is allowed to equalize around the collar body.

Fluid spirals are actually convex surfaces which prevent drill collar from balling up and also result in only a 4 percent loss of drill collar weight.

Collar is available on rental in Texas-Louisiana Gulf Coast area in 6, 4¾, and 4⅛-in. sizes. *Engineering Enterprises.*

Circle number (22) on reply card.

Pressure Control Pilot



New high-low pressure control pilot has been developed by Merla Tool. Called Type E-1, new control has separate high and low pressure sensing elements to allow pressure to be taken from two separate points.

Pilot is used as a pressure safety control high-low shut-off and for well purger, back pressure and pressure reducer service. A wide pressure range (0-200 psi) is available through use of interchangeable pressure range springs.

It also features snap-action; pressure-balanced diaphragms; resilient, large area, non-leak seat; non-bleed pilot; torque-free spring action; low friction piston seal and non-corrosive parts with over-range protection for pilot section. *Merla Tool Corporation.*

Circle number (23) on reply card.

Macaroni Tubing

Macaroni size electric weld oil well tubing, in ¾, 1, 1¼ and 1½ in. nominal IPS sizes and 2 1/16 in. OD, have been added by Standard Tube. Macaroni tubing is also available in 1½ in. IPS size with a 0.125 in. wall thickness.

Various types and sizes of macaroni tubing listed are available in J-55, H-40, and F-25 grades with plain, non-upset and upset ends in accordance with API standards where applicable.

Most sizes are also available with integral box and pin type joints. *Standard Tube Company.*

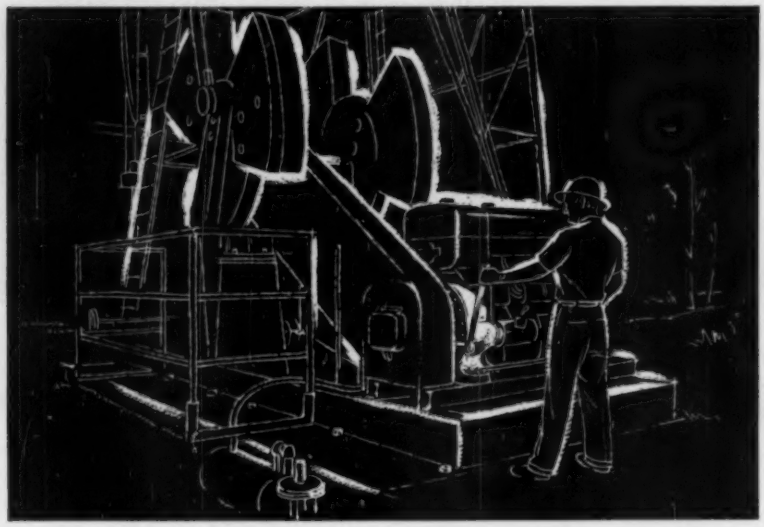
Circle number (24) on reply card.

Multiple Completion Wellhead Equipment

New concept in multiple completion wellhead equipment is capping quadruple producer in South Texas. Quad Tree controls gas flow from 4800 ft, and three oil flows from 5800, 6200, and 6250 ft. Hookup is versatile in that one or more valves can be removed without disturbing remaining valves.

Hookup will allow any combination of zones to be flowed or pumped. In this installation, all tubing strings are parallel. *Oil Center Tool Company.*

Circle number (25) on reply card.



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It's no wonder why more and more oil men specify Rockford PTO's. These maintenance-free PTO's offer higher torque capacities, better heat dissipation, less lever pressure, and positive engagement. Rockford's infinite-control adjusting ring provides longer life. Smooth and instantaneous power is transmitted from any internal combustion engine to your working oil field equipment.

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For cementing or recementing, plug-backs or squeezes, at varying depths, pressures, drilling conditions, UNAFLO oil-well cement provides the workable slurry — one that pumps easily, sets hard.

For lesser depths, results are good whether UNAFLO is used neat or plus additives to lighten slurry weight when high fillups are desired.

At any depth, its slurries sustain high initial fluidity, and its retarded set allows proper placement with an added margin of safety for delays or emergencies.

For more information, write Universal Atlas Cement, 100 Park Avenue, New York 17, N. Y.

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CEMENTING DATA

Job — Clemile Savoy #1, Vermillion Parish, Louisiana

Owner — Continental Oil Company, Houston

Contractor: Dillard-Waltermire, Inc., Houston

Job #1 — 11,030′ of 9⅝″ O.D. casing cemented in 12¼″ hole with 1,000 bags neat UNAFLO cement. Slurry fillup behind casing 3,130′. Drilling mud wt. 11.5 lbs/gal. Schlumberger temp. log 168° F. Est. static BHT 193° F.

Job #2 — 1,298′ of 7″ O.D. liner set in 8⅜″ hole from 10,910′ to 12,208′, cemented with neat slurry 220 bags UNAFLO. Drilling mud wt. 16.2 lbs/gal. Schlumberger temp. log 196° F. Est. static BHT 226° F.

Job #3 — Squeezed top 7″ O.D. liner with 300 bags neat UNAFLO. Final pump truck pressure 2,000 psi.

Job #4 — Squeezed 150 bags Cealment (UNAFLO plus latex) through retainer set at 12,182′ into lost-circulation zone below 7″ O.D. liner.

Jobs #5, 6, 7 — Bradenhead squeeze jobs using 100 bags; 150 bags; 150 bags Cealment respectively into lost circulation zone at 12,350′. Final pressure 400 psi.

Job #8 — 2,725′ 4½″ O.D. liner set in 6″ hole from 12,017′ to 14,742′ cemented with 300 bags UNAFLO weighted (18 lbs/gal.) with HiDense #2 (Ilmenite Ore). Mud wt. 18.4 lbs/gal. Est. static BHT 284° F.

Job #9 — Full string of 7″ O.D. casing tied into top of 7″ O.D. liner at 10,910′, cemented with 50 bags neat UNAFLO.

Universal Atlas Cement
Division of
United States Steel

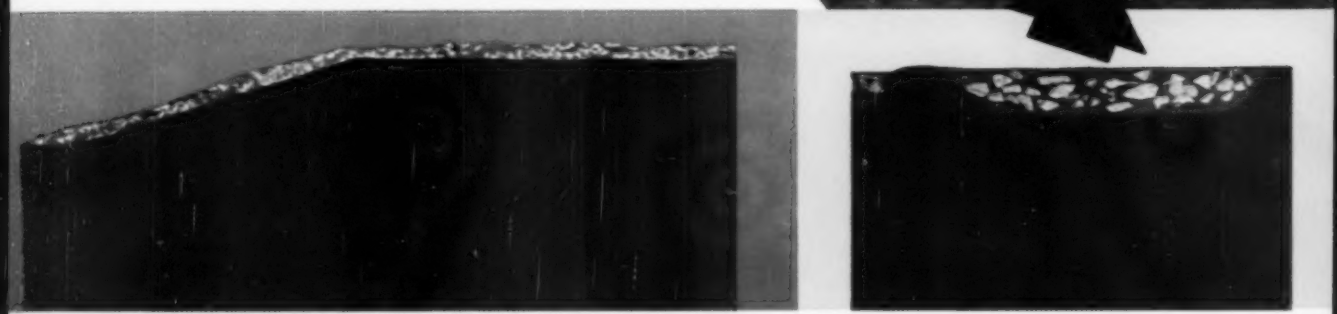
FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

HUGHES

hardfacing

doubles – often triples – life of your tool joints

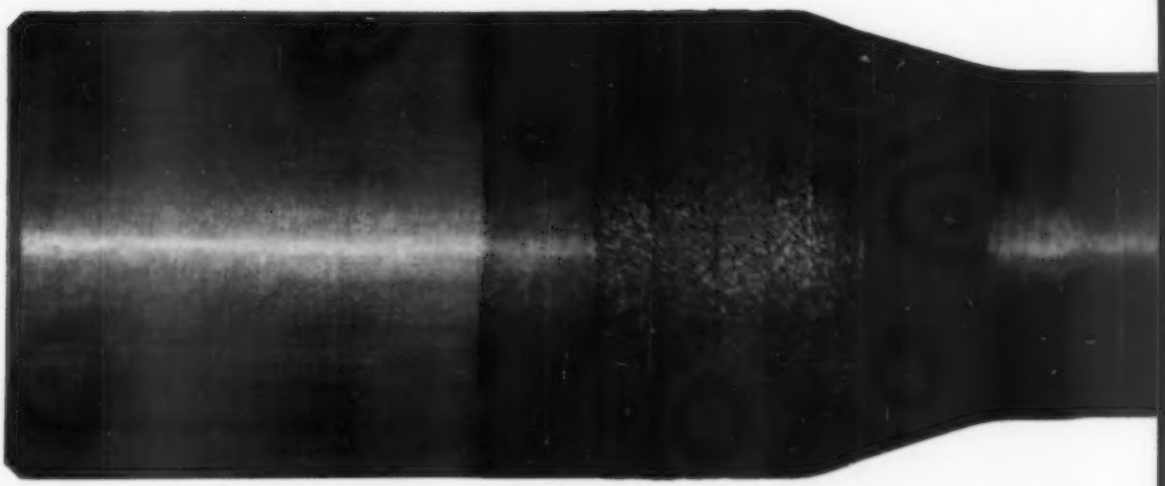
There are three outstanding reasons why Hughes hardfacing gives your tool joints long, superior protection against wear: 1) Quality of the hardfacing material – *Hughesite* – 25 times more wear resistant than hardened steel. 2) Method of application which assures an even distribution of *Hughesite* particles in the hardfaced bands. 3) Inspection of hardfacing to check the bonding of the hardfacing to the parent metal of the tool joint.



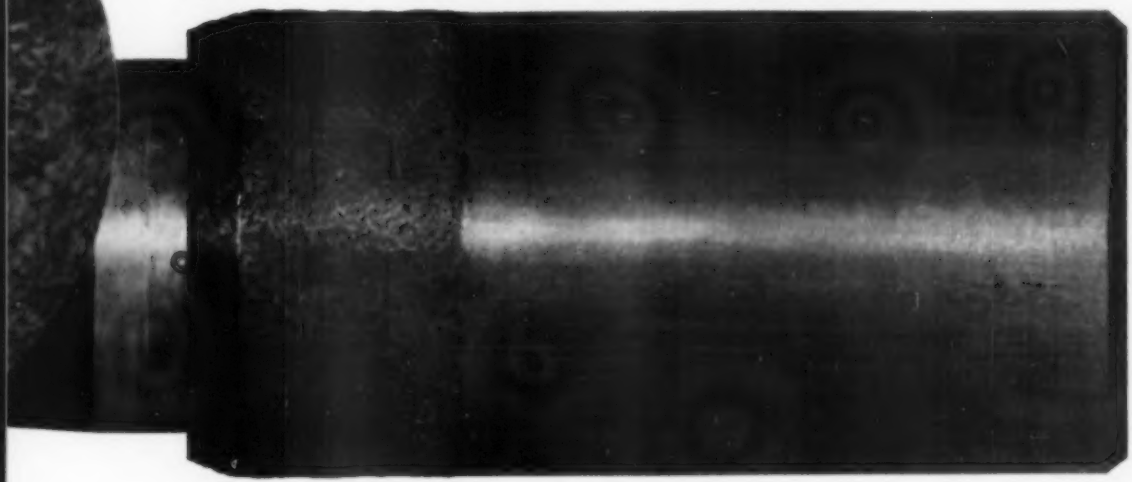
HARDFACING AS SEEN BY METALLURGICAL CAMERA. Large photograph, top, is a photomicrograph of a pinpoint of *Hughesite*, magnified 2,000 times. The cross section of a single band of hardfacing, right – magnified about three times – shows the even distribution of *Hughesite* particles throughout the hardfaced area. This assures uniform wear resistance during life of the hardfacing. The photograph at the left is a section through one of the fingers of hardfacing. These fingers provide continuous hardfacing through the circumferential lands and down the tapered elevator shoulder to provide maximum protection for the lands and elevator shoulder.

Hardfacing in depth was pioneered by Hughes to lengthen tool joint life. Developed and manufactured by Hughes and adapted to tool joint hardfacing, *Hughesite* is a *pure* tungsten carbide, many times harder than the hardest mineral formations encountered in oil well drilling. It is the hardest material that can be successfully used to hardface tool joints. Because of its fine-grained structure (see the color photomicrograph), *Hughesite* possesses the unique combination of hardness and toughness needed to withstand shock and abrasion.

The even distribution of *Hughesite* particles, achieved through the Hughes method of applying the hardfacing, assures *uniform resistance to wear* during the



"FLASH-WELD" tool joints – taper and square shouldered – are hardfaced with three, four or five bands of *Hughesite*. Five are standard on taper shouldered and four bands on square shouldered joints and are recommended where severe wear conditions exist. Fingers of hardfacing extending through the circumferential lands and onto the elevator shoulder on both taper and square shouldered joints, protect against undercutting in these critcial wear areas.



"SEAL-GRIP" tool joints are available with three or four bands of hardfacing. Four bands are standard. Sled runner design and interruption of the guide ribs with hardfacing provide a wear-resistant surface that protects the guide ribs and adjoining surfaces against undercutting.

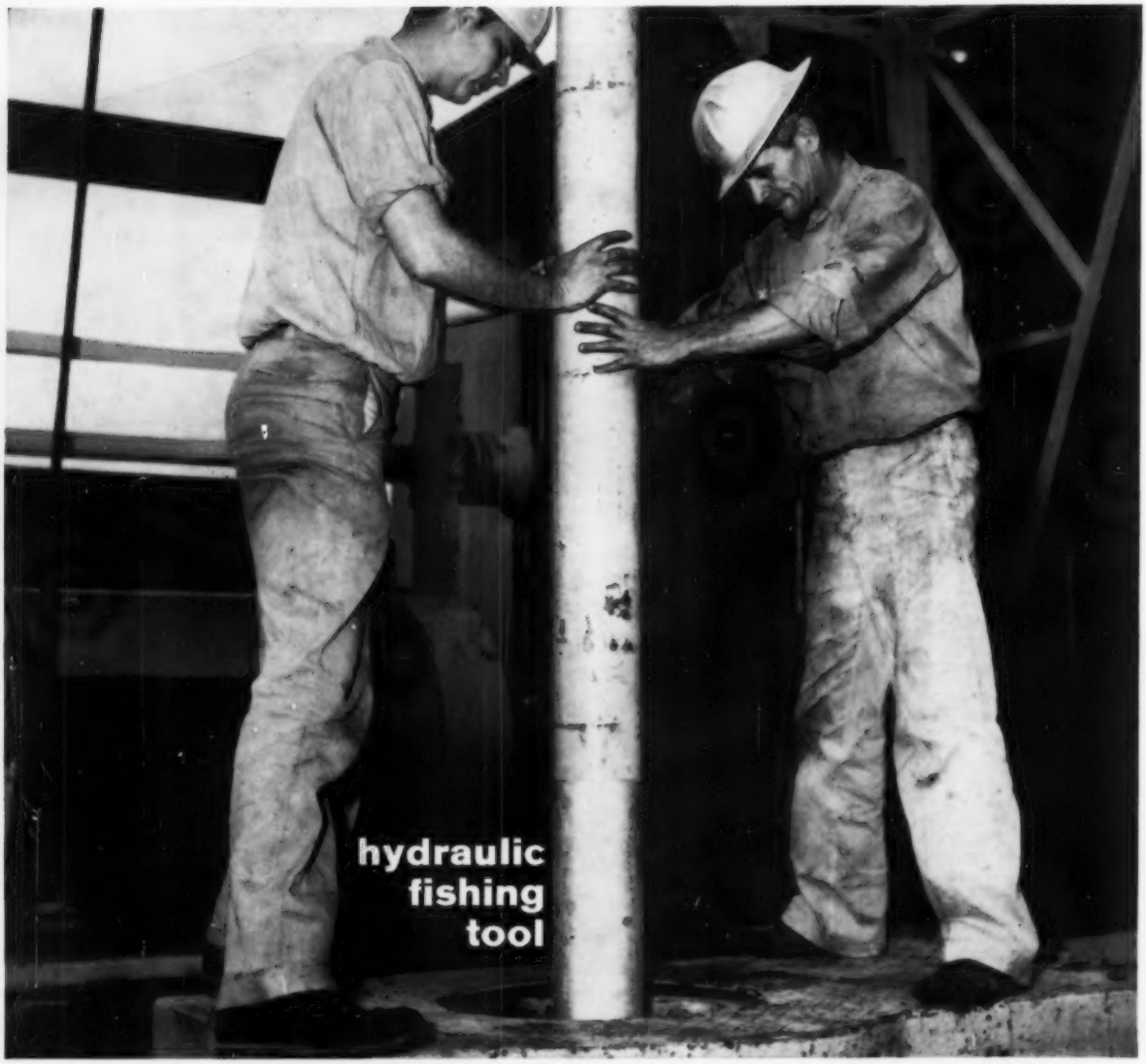
entire life of the hardfacing. One of the major advantages of Hughes "Flash-Weld" joints is the fact that they may be *safely* re-hardfaced in the field as many times as the life of the drillstem will justify.

The combination of highest quality material, method of application and inspection provides wear resistance that makes Hughes hardfaced joints equivalent to an extra set, and often two sets, of non-hardfaced tool joints . . . at a fraction of their cost.

"SNOW TESTING" is an added and unique Hughes inspection method that serves as a positive check of the bonding of hardfacing material to the parent metal of the tool joint.

HUGHES TOOL COMPANY

DEVELOPERS OF "FLASH-WELD" AND "SEAL-GRIP" TOOL JOINTS



Delivers a 300,000 pound "knock-out" punch; critical parts are 4340 nickel alloy steel

. . . it provides the hardness, impact resistance, and strength needed to withstand the shattering impact.

Every time this hydraulic "sledge hammer" is run down a well to free stuck pipe, 4340 nickel alloy steel is put through one of the severest tests of a metal's strength and impact properties.

Blows of over 300,000 pounds are delivered by this Bowen Hydraulic Rotary Jar when "fish" are stuck tightly. But time and time again, this through-hardening nickel alloy steel proves it has the high mechanical properties to withstand the crippling impact.

THE TOUGH JOBS GO TO NICKEL ALLOY STEELS. Because of their outstanding strength—their high fatigue and impact resistance—producers have come to depend on nickel alloy steels for long, reliable service in the most demanding applications. Rock bit cutters, for example. Hole reamers. Drill pipe. Sucker rods. Fishing taps. In these applications, nickel alloy steels prove their dependability by providing *trouble-free* performance.

WHAT ABOUT YOUR EQUIPMENT? Do you need materials with greater strength and toughness, with greater impact resistance? Do you need materials that respond readily to heat treatment? Nickel alloy steels may prove to be your answer. For complete data, send for your copy of "The Properties of Heat Treated Wrought Nickel Alloy Steels." A postcard will do it.

TYPICAL MECHANICAL PROPERTIES
4340 nickel-chrome-moly steel

Tensile Str. 1000 psi		Yield Str. 1000 psi	
As Rolled	192	As Rolled	147
Annealed	119	Annealed	99
Hard. & Temp.[a]	150[c], 220[d]	Hard. & Temp.[a]	130[c], 200[d]
Hardness (Brinell)		**Impact Str. ft.-lb.**	
As Rolled	380	Izod. Hard.	
Annealed	240	& Temp.	73[c], 16[d]
Hard. & Temp.[a]	310[c], 445[d]		

[a] Properties after heat treatment are based upon oil quench and 1-in. round bars.
[c] Tempered at 1200° F [d] Tempered at 800° F

THE INTERNATIONAL NICKEL COMPANY, INC.
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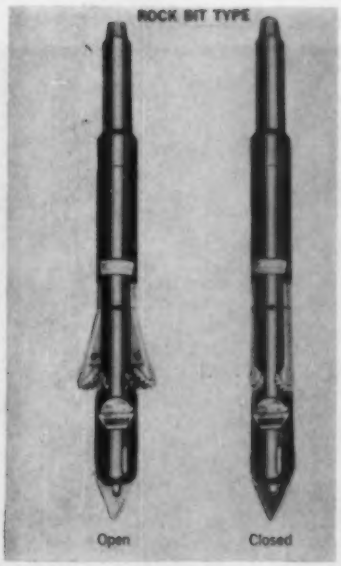
NICKEL MAKES STEEL PERFORM BETTER LONGER



Tool Enlarges Hole

Servco tool is run through casing to enlarge hole for subsequent operations such as gravel packing, cementing, landing casing or liners, wall scraping, or for any purpose where a larger hole diameter is desired.

Two types of new tool are available. Rock bit type enlarges drilled hole up to twice drilled diameter in soft or hard formations. Blade type opens drilled hole to a larger diameter simultaneously with the drilling operation in soft to medium hard formations. Full fluid flow passes through jets of standard bits, none is bypassed, and hole size can be increased to about ¼ greater than the drilled hole. *Servco.*

Circle number (26) on reply card.

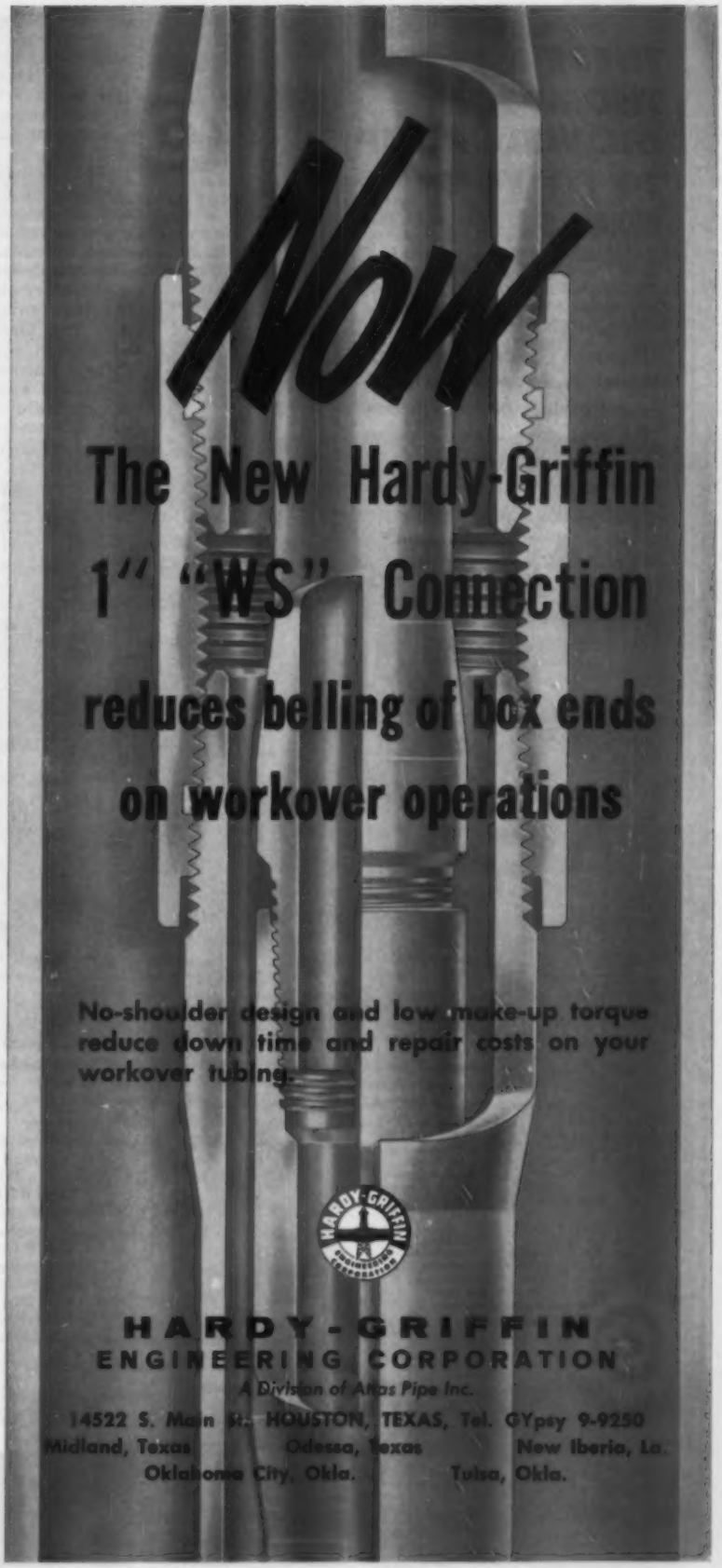
Blow-Out Preventer Unit Includes Accumulators

Payne Type E automatic pump accumulator unit has accumulators that need not be removed for field service as they are used as vertical structural members of the unit, welded in place on skids as main sections of the assembly.

Unit is designed to produce a stronger arrangement which remains in balance, simplifying handling and increasing safety factors by protecting gages, control valves, and lines.

Units are available in sizes from 20 to 80 gallons with Payne Two-Stage-Double-Acting-Pump and Automatic Unloading Valve. Fluid control manifolds are supplied with ¾-in. 3000 psi stainless steel 4-way valves. Automatic controls and pumps are protected by steel covers, heavy duty skids and lifting eye for handling. *Payne Manufacturing Company.*

Circle number (27) on reply card.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The New Hardy-Griffin
1" "WS" Connection
reduces belling of box ends
on workover operations
No-shoulder design and low make-up torque reduce down time and repair costs on your workover tubing.
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THERE'S A THOMPSON OIL WELL PUMP TO FIT YOUR NEEDS!

Featured
THIS MONTH:

Thompson's popular "traveling-barrel" type combination (single metal plunger and 6-cup) bottom hold-down pump provides steady production and long operating life. This sand-resistant pump performs well under most fluid-lifting conditions. It can also be equipped with a sand-flush valve to clean the barrel ahead of the plunger. Bore sizes: 1½", 1⅝", 2", 2⅛", and 2½".

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SERVICE STORES for your convenience! Stores have service men as well as salesmen to serve you . . . prompt pick-up and delivery!

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Healdton, Okla.-Ph. 668
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Kilgore, Texas-Ph. 3614
Hatchee, Miss.-Ph. 4795
Oil City, Miss.-Ph. 6615
Reed City, Mich.-Ph. Texas 2-2461
Seminole, Okla.-Ph. 610
Shidler, Okla.-Ph. MI 3-2011
Stephens, Ark.-Ph. ST 6-5487
Vivian, La.-Ph. 3680

SUPPLY STORES
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John & Paul Pump & Supply, Gladewater, Texas
Jack Yates Pipe & Supply Co., Gladewater, Texas
Midway Pipe & Supply Co., Groggton, Texas
W-B Pump & Supply Co., Pampa, Texas
B-H Pump Service, Salmon City, Texas
Happy Co., Salem, Illinois

Thompson
PUMP COMPANY
Drawer 591 Okmulgee, Oklahoma

Automatic Well Tester

Automatic Well Test and Data Panel Model WT-300 was designed to automatically test 25 or any multiple of 25 oil wells.

Features of the panel are automatic control of all testing functions; rack-mounted with pull-out drawer modules; purge timer, test timer, and skip-test well selector switches; oil, gas, and water counters are provided for tabulation and storage of data during test.

An electric typewriter is provided to automatically type out test data at the end of each well test period. Typed data consists of the volume of oil, gas, and water, date, time and well code number. This information is printed in a maximum of 10 seconds.

Panel may be located either in central office or in the field, using a two-wire communication system or microwave for thansmission to the central office. *Instruments, Inc.*

Circle number (28) on reply card.

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OIL FIELD CHEMICALS

Developed exclusively for solving particular problems in the petroleum industry.

P.T.C. . . . The original Paraffin Treating Chemical. Holds paraffin in suspension from formation to refinery.

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CORROSION INHIBITOR CI-123 . . . Designed especially for control of oil field corrosion problems.

GYP and SCALE TREATMENT GS-20 . . . Effective on these types of carbonates and sulphates: calcium, strontium, barium and magnesium.

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Power Swivel for Light To Medium Drilling

The PS-70 power swivel is a rotary power unit, designed to be attached to and rotate drill pipe and tubing for light to medium drilling operations. Speed and torque are controlled from a remote portable console, with speeds up to 100 rpm in either direction and torque up to 4000 ft-lb.

With a minimum of moving parts, the unit operates under load at maximum speed for an indefinite period without overheating or other adverse effects. Fire hazard is minimized as the power unit may be spotted at a safe distance from the wellhead. All moving parts are completely sealed and protected by full-time lubrication. *Wilson Supply Company.*

Circle number (29) on reply card.

Rig Trailer Assembly

Fox Equipment has published a new four-page brochure describing the three-in-one Crusader mast and substructure trailer assembly. Designed for drilling, workover, or servicing, unit is available in either 86 or 96-ft heights. It is only mast of its size that hauls complete with substructure as one load. *Fox Equipment and Derrick Company.*

Circle number (30) on reply card.

Epoxy Industrial Coating For Corrosion Protection

Advanced coal tar epoxy industrial coating designed for high resistance to corrosion and abrasion has been introduced by Napko.

Film resists exposure to salt water, mineral acids, alkalis, or petroleum products. It also resists abrasive wear from barnacles, sea flotsam, or soil particles driven by sea or wind.

Special custom formulations to meet specific corrosion problems can be produced to stretch life of film beyond normal standards. Laboratory tests have shown it to be compatible with cathodic protection.

Theoretical coverage is 150 sq ft per gal with film thickness of 8 mils. It drys sufficiently for recoating and handling in 14 to 16 hours at 70 deg. *Napko Corporation.*

Circle number (31) on reply card.

Polished Rod Packing

A polished rod packing with semi-metallic construction which forms a dense, shock-absorbing, bearing-like surface has been produced by Marlo Company and is being distributed by Axelson.

Packing is designed to eliminate hardening or burning during pump-offs. These characteristics also help to reduce power costs, manufacturer states, since packing is anti-frictional. It is resilient and corrosion-resistant. *Axelson Division of U.S. Industries.*

Circle number (32) on reply card.

Bellows Relief Valve Has Alarm System

Bellows relief valve for vapor service, introduced by J. E. Lonergan, has several unique features.

An alarm warns of bellows rupture, either as a self-contained unit or remotely controlled, and a versatile cap arrangement provides a bolted standard cap which can be interchanged with a packed cap. Cap contains provision for gaging without taking the valve out of service.

Company's hydro design valve is designed to eliminate chatter. There are 2 seating surfaces in one disc, which allow it to be reversed if one side is damaged. Valve provides a balancing action against a variable back pressure. *J. E. Lonergan Company.*

Circle number (33) on reply card.

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AS
INSURANCE...
CUT-A-WAY VIEW OF
PRODUCTION STRING
TUBING
SNAP-ON GUIDE
SUCKER ROD
SNAP-ON GUIDE
We all insure our valuable equipment against accidental damage or loss. Why not help insure expensive tubing and sucker rod strings against unnecessary wear and service by making a small investment in OIL STATES Rubber Sucker Rod and Tubing Guides?
IT JUST MAKES GOOD BUSINESS SENSE!
Invest a little to protect a lot. OIL STATES Guides protect your tubing and rods because they:
• Prevent metal-to-metal contact between rods and tubing
• Centralize tubing in casing, minimizing "breathing" of tubing
• Lessen wear on pump by deadening "rod whip"
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OIL STATES RUBBER SNAP-ON GUIDES ARE EASILY INSTALLED AS RODS AND TUBING GO INTO THE WELL. THEY DO NOT OBSTRUCT FISHING TOOLS.
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OSR-12

RUNNING TOUR with MEN in the INDUSTRY

▸ American Petrofina, Inc. announced the election of new officers to the board of directors who will also serve as corporate vice presidents. They are: **John M. Shea Jr.,** in charge of the refined products marketing; **Ralph E. Damp,** in charge of all oil and gas production and exploration operations.

▸ Atlas Powder Company has elected **Thornton F. Bradshaw** to the board of directors. He is a vice president and member of the board of the Atlantic Refining Company and very active in Philadelphia civic affairs, being president of the Chamber of Commerce of Greater Philadelphia.

▸ **William V. Stiles** received his degree in electrical engineering at Montana State College and has accepted a position as research engineer in the exploration division, La Habra Laboratory of the California Research Corporation.

▸ **Reese H. Tucker** was elected vice president of Cities Service Co., serving as coordinator of exploration and production. **E. W. Dissler** of Calgary will serve as new manager of exploration for Cities Service, succeeding Tucker.

▸ **Frederic B. "Fritz" Loomis** is the new chief geologist of the Denver exploration and production division of the Clark Oil and Refining Corporation.

▸ **W. C. Stout** of Continental Oil Company has been promoted to the newly-created position of coordinator of reserves and production acquisitions. **G. S. Sawvel** will serve as regional engineer of the western region.

▸ Drilling and Exploration Company, Inc. has re-elected its slate of officers for the forthcoming year. They are: **Chas. R. Rider,** president; **G. R. Brainard Jr.,** executive vice president; **Robert L. Rose,** and **E. A. Roberts Jr.,** vice presidents; **Robert H. Huey,** secretary-treasurer; and **Dougall C. Fraser** and **Gael Agan,** assistant secretaries.

▸ The Empire State Petroleum Association, Inc. elected **Charles A. Lockard** secretary, succeeding the late Harry B. Hilts. Lockard has been assistant secretary since February 1946. **Robert A. Stromberg** was appointed assistant secretary.

▸ **H. C. Teasdel** and **Glenn M. Forgan** have been elected vice president-director and director, respectively, of the General Gas Corporation. Teasdel has served as president and chairman of the board of The California Company and Forgan as vice president of the First National Bank of Chicago.

▸ **Joseph F. Mueller** has joined Keplinger and Wanemacher of Tulsa. He was formerly with Pan American Petroleum Corporation as a reservoir engineer in their Denver office.

▸ **J. W. Pittman** was named manager of the New Orleans production department of Shell Oil Company, succeeding **W. R. Lund** who will be production manager in Houston. **L. Kerlin** becomes exploration manager, replacing **G. A. Burton** who is transferring to Los Angeles as exploration manager of the Pacific Coast Area. **R. L. Ferris** is the new chief exploration engineer for the Houston area, succeeding **C. V. Cameron,** who has been appointed head of a newly-created systems engineering group in Houston.

▸ **J. E. Trigg** of Trigg Drilling Company has been elected a director of Tekoil Corporation.

▸ **Leon L. Fergus,** formerly with Sohio Petroleum Company, has joined Trunkline Gas Company, as superintendent of land.

▸ Tennessee Gas Transmission Company created a new district production office in Lafayette, Louisiana, handling drilling and producing operations of the company in on shore South Louisiana areas and in Mississippi. **M. E. Fox,** district production superintendent, **G. H. Gilbreath,** district foreman, **G. P. Walker III,** district petroleum engineer, **J. P. Cox,** district office supervisor, **H. H. Castleberry Jr.,** division office supervisor.

▸ Petroleum Property Management, Inc., a new company to supervise oil and gas production and development operations for others on a contract basis, has been formed by **H. J. Gruy and Associates, Inc.** The new company is designed to serve the growing needs of individuals and companies requiring management of field operations without maintaining their own full-time staffs.

▸ **Lloyd O. Fox** was appointed secretary-treasurer, succeeding the retiring **Wilbur A. Wiegand,** of Sharples Oil Corporation. **Robin J. Corbett** has been named manager of production, succeeding **Max S. Loy** who resigned to open his own office in Chanute, Kansas, as a petroleum consultant specializing in water flood properties.

▸ **Warren C. Johnson** and **M. S. Hubbell** have been named president and manager, respectively, of the Lomita Gasoline Company, a subsidiary of the Standard Oil Company of California. **J. Q. Cope** has been appointed vice president of California Chemical Company, another of California's subsidiaries.

▸ **D. C. Wixson** was named administrative vice president for the Sunray family of companies.

▸ **T. H. Wallace** has resigned as Western Gulf Oil vice president. **A. M. Bell Jr.,** vice president, will supervise the activities of Western Oil, a wholly-owned subsidiary of Gulf Oil Corporation.

▸ Kerr-McGee Oil Industries, Inc. announced a number of changes in their exploration department. **Robert B. Capps** was named assistant chief geologist in charge of development operations in coastal and offshore areas. **Robert L. Duncan** has been appointed division manager of the New Orleans area and **J. Robert Stevenson** was named division manager in Canada.

▸ **Hobson L. Mann** has joined King-Stevenson Oil Company, Inc., as division production engineer of the Southwest division, Oklahoma City. He was formerly with Bodard Drilling Company.

▸ **Wilbur R. Lilly** and **Harold R. Mayer,** former Gulf Oil Corporation engineers, have opened offices in Jackson, Mississippi, specializing in oil and gas reserves, property evaluation, drilling and completion, production and State Oil and Gas Board hearings.

▸ **J. Gregory Merrion** resigned as district engineer for British-American Oil Producing Company's Southwestern district and opened his own general petroleum consulting office in Farmington, New Mexico.

▸ **Ralph W. Collins** has been appointed vice president in charge of production of Midwest Oil Corporation, in Denver, Colorado.

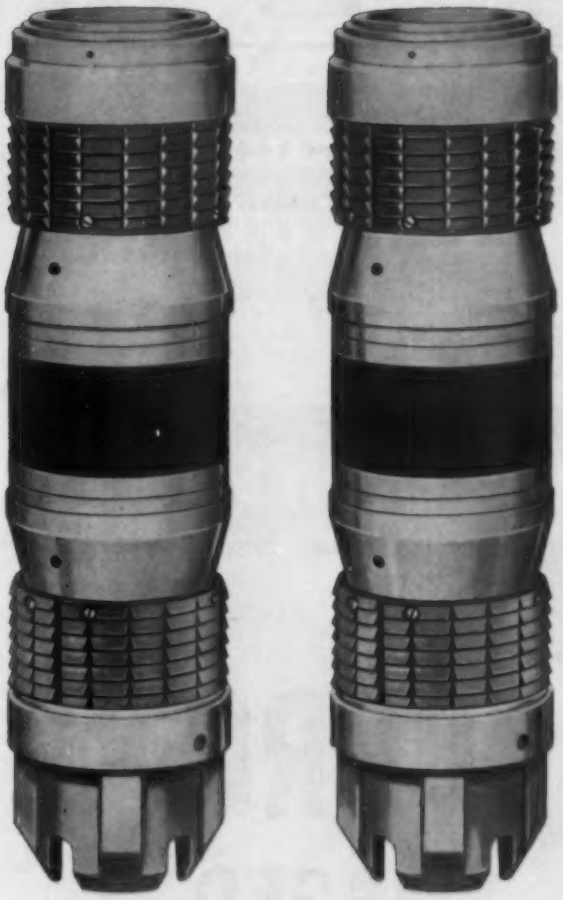
▸ **Pan American Venezuela Oil Company** is the new name for Pan Venezuelan Oil Company. There will be no alteration in operating practices.

▸ Sinclair Oil and Gas Company announced the following personnel appointments: **Dick T. Fenwick,** assistant to vice president; **L. G. Rheinberger,** head of the gas and gas products department, Tulsa; **C. H. McClure,** transferring to Denver to succeed Fenwick; **Richard M. Kobdish,** elected vice president and manager of the Central division in Tulsa.

▸ **LeRoy W. Holm** has been promoted to supervisor of the secondary recovery section of the production engineering research division of the Pure Oil Company's research center.

API Eastern District Award Winners

At the Eastern District Meeting of American Petroleum Institute's Division of Production in Pittsburgh, API "Citation for Service" awards were presented to M. H. Flood, The Ohio Oil Company, Jonesville, Michigan; Lysle R. Kirk, Ohio Fuel Gas Company, Columbus, Ohio; and E. E. Powell, Esso Research & Engineering Company, Pittsburgh. "Meritorious Service" awards went to Bill G. Harmon, B. G. Harmon Service Company, Carmi, Illinois; and V. F. Sargent, Michigan Department of Conservation, Mt. Pleasant, Michigan. Presentations were made by L. E. Fitzjarrald, Bartlesville, Oklahoma, vice president of Phillips Petroleum Company and API vice president for production. Pictured are (left to right): Powell, Fitzjarrald, Kirk, Harmon, Flood, and Sargent.



LEFT: SIZE 3B
BAKER WIRE LINE
BRIDGE PLUG
PRODUCT 400-N
RIGHT: SAME

IDENTICAL

The Baker Bridge Plug on the left was made a year ago. The one on the right is new. The two are identical—no design changes for a year. Why no changes? Is the design that good? The answer is yes.

For the first few years, changes came fairly often. Now they come few and seldom. The design is now a stable one—tested, refined, proved in thousands of wells. The weak points have been sifted out, the strong points made stronger.

The design is stable but it isn't frozen. Our engineering studies continue. We're always on the alert for any chance to make a good design better.

And consider this: the two plugs in the picture are not only alike in design, they match each other in quality. They're identical in dimensions, materials, workmanship. The men who design and build Baker plugs insist that it takes uniform quality to give you uniform dependability.

Today's Baker Bridge Plugs master any well—the average wells and the hot, high pressure wells. They are tough and reliable.

Baker plugs are short. They drill up quickly and easily. They're made in drillable, corrosion-resistant cast iron for permanent service, and in fast-drilling magnesium for temporary service.

Leading Wire Line Companies set Baker Wire Line Bridge Plugs accurately and promptly. Other models can be set on tubing or drill pipe.

BAKER BRIDGE PLUGS

BAKER OIL TOOLS, INC. HOUSTON / LOS ANGELES / NEW YORK

SUPPLIERS' PARADE

New Companies, Subsidiaries & Agents

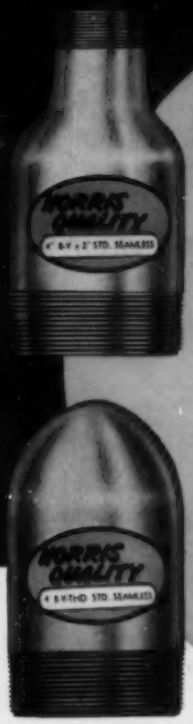
Automation Industries, Inc. announced contractural and licensing agreements with Halliburton Company through its Welex subsidiary enabling Halliburton to enter the field of ultrasonic non-destructive testing in the oil and gas industry. Foreign and domestic markets will be sought.

Baker Oil Tools, Inc's new subsidiary, Baker-Herramientas Petroleras, S.A., in Mexico City, will begin operations in 1960 under the management of J. R. Baker. Baker has also transferred its research headquarters to Houston from Los Angeles and plans a major expansion of facilities there.

Bucyrus-Erie Company's drill sales operations were transferred from Richmond, Indiana, to the main offices at South Milwaukee, Wisconsin.

Continental-Emsco Company now has supply stores located at Venice, Harvey, Houma, Leeville, Morgan City, Lafayette and Lake Charles, Louisiana.

Always at your Supply Store



W. C. NORRIS SWAGED NIPPLES and BULL PLUGS

Safety . . . craftsmanship . . . durability . . . precision . . . yes, these elements are important in Swaged Nipples and Bull Plugs. And, these are the elements found in *all* W. C. Norris fittings — elements proven by the experience of our customers.

W. C. NORRIS, MANUFACTURER
DIVISION OF DOVER CORPORATION
NORRIS QUALITY OIL WELL SUPPLIES
P. O. BOX 1739 • TULSA, OKLAHOMA
BRANCHES: Great Bend, Kansas; Corpus Christi, Houston, Kilgore, Odessa, Wichita Falls, Texas; Oklahoma City, Oklahoma; Salem, Illinois; Casper, Wyoming; Farmington, New Mexico; Edmonton, Alberta, Canada.
Buy From Your NORRIS Distributor

Daniel Orifice Fitting Company named Chipley and Jensen, Inc., Milwaukee, exclusive sales representative in that area.

Dodge Manufacturing Company has established an international sales organization, Dodge Manufacturing International, AG, headquarters in Zug, Switzerland. They have also acquired majority interest in their new subsidiary, Dodge de Mexico, S.A., whose main office is in Mexico City.

Dow Chemical Corporation and **Schlumberger Ltd.** have formed a new company to be known as Dowell Schlumberger Corporation, offering all Dowell services and Johnston Tester's drill stem testing in countries other than the U. S. and Canada. The new corporation will headquarter in London with Tromer R. Smith, manager of operations.

Homco opened a new service branch in Ruston, Louisiana, equipped to furnish complete fishing and cutting; directional drilling and electrical well services as well as oil field rentals.

Maloney-Crawford Tank and Manufacturing Company has named H & S Service Company, Greggton, Texas, representative providing service and inventory for the East Texas area. Allan Hanson, sales and service manager.

Odex Engineering Company of Odessa opened a new divisional office housing sales and shop facilities in Oklahoma City, Tom Sherrill, division manager.

Parks Equipment Company has set up a new sales and service organization, Parquip, Inc., with engineering services and products available to all systems and tank fabricators. W. R. "Bud" Lee will act as West Texas branch manager with offices in Odessa.

Appointments and Promotions

Aero Service Corporation—**Robert H. Randall,** vice president, formerly with U. S. Bureau of the Budget.

Armite Laboratories—**Paul V. Wampler,** manager of sales and assistant to executive vice president; **Jim Wright,** manager of sales for Armite Industries Division.

Bethlehem Steel Company, Supply Division—**E. R. Phillips,** manager for the Rocky Mountain region.

Clark Bros. Company, one of the Dresser Industries—**C. R. Apitz,** senior sales engineer for Houston office.

Continental-Emsco — **Godfrey Cajthaml,** district manager Calgary district.

Delta Tank Manufacturing Co., Inc.—**Ralph Kemp Jr.,** sales representative for oilfield equipment division.

Dowell Division of Dow Chemical Company—**Neil Miller,** treasurer; **T. R. Harrison,** assistant treasurer.

Grove Valve and Regulator Company —**Dale N. Johnson,** sales and service representative, Houston.

Pacific Pumps, Inc.—**Doran B. Harney,** chief engineer.

Quality Must Be Preserved If Performance Is To Be Assured

. . . and the final proof of quality in sucker rods is how well they perform in the well.

That is why LIBERTY MANUFACTURING COMPANY of Texas spares no effort or expense to assure producers everywhere that Liberty Sucker Rods arrive at the well site in the same excellent condition as when they left the inspection line at the plant.

This is accomplished by attaching rubber thread protectors both to the pin ends and coupling ends of the rods. These protectors are color coded for easy identification of rod types. They afford genuine shock resistance, will not vibrate loose during transit, and are quickly removed without hammering as the rods are made up to go into the well.

Palletized Packaging is available upon request at no additional charge. This type of packaging cuts handling costs and insures the delivery of straight rods to the well.

The careful preservation of quality in LIBERTY Rods is reflected in longer, trouble-free performance in the production string. For in all operations, from manufacturing to safe delivery, the goal at LIBERTY is not to produce the most sucker rods in the least time, but to produce the finest sucker rods . . . regardless of time!

FOR EXCELLENT PRODUCTS AND SERVICE
SPECIFY LIBERTY SUCKER RODS AND PUMPING UNITS

• SOLD ONLY THROUGH SUPPLY STORES •

LIBERTY

MANUFACTURING COMPANY OF TEXAS

4025 HEMPHILL STREET • FORT WORTH, TEXAS

Reed Roller Bit Company—**Robert L. (Bob) Walker,** staff engineer, formerly division production superintendent for Shell Oil in East Texas.

U. S. Industries—**Hugh C. Bream,** president and general manager Western Design; **Robert S. Wright,** vice president of International Trade; **C. C. Call** and **Jack Lee Thompson,** district managers, hydraulic department, Axelson Division.

Republic Supply Company, division of Republic Steel—**Walter J. Slaughter,** district manager, Oklahoma district formerly division manager of Parkersburg Rig and Reel Company's Rocky Mountain division; **W. E. Levell,** assistant district manager, Oklahoma district.

Schlumberger Well Surveying Corporation—**R. D. Shay,** sales engineer, Artesia, New Mexico; **T. G. Evenson,** sales engineer, Newcastle, Wyoming; **F. D. Fulkerson,** area staff specialist Northwest Texas area.

Hagan Chemicals & Controls, Inc.—**James H. Holben,** assistant director of Bradford Laboratories, Pittsburgh; **James M. Clayton,** manager of Evansville Laboratory.

Jones & Laughlin Steel Corporation—**Joseph A. Heineman Jr.,** resident manager of sales, Tulsa.

Baash-Ross Division, Joy Manufacturing Company—**Ray E. (Flash) Gorman,** regional sales manager of Mid Continent and Permian Basin areas and Dallas-Fort Worth district.

Parkersburg Rig & Reel Company—**Jess Kern,** marketing manager, Coffeyville, Kansas, plant; **J. W. Robbins,** marketing manager, production equipment plant, Houston; **Howard Kaylor,** field sales engineer for all oil field equipment plants.

Magnet Cove Barium Corporation, one of the Dresser Industries—announced changes in their drilling mud department: **George H. Moore,** assistant vice president—sales; **Ray E. Dillman,** assistant sales manager—Northern area; **L. B. Gale Jr.,**

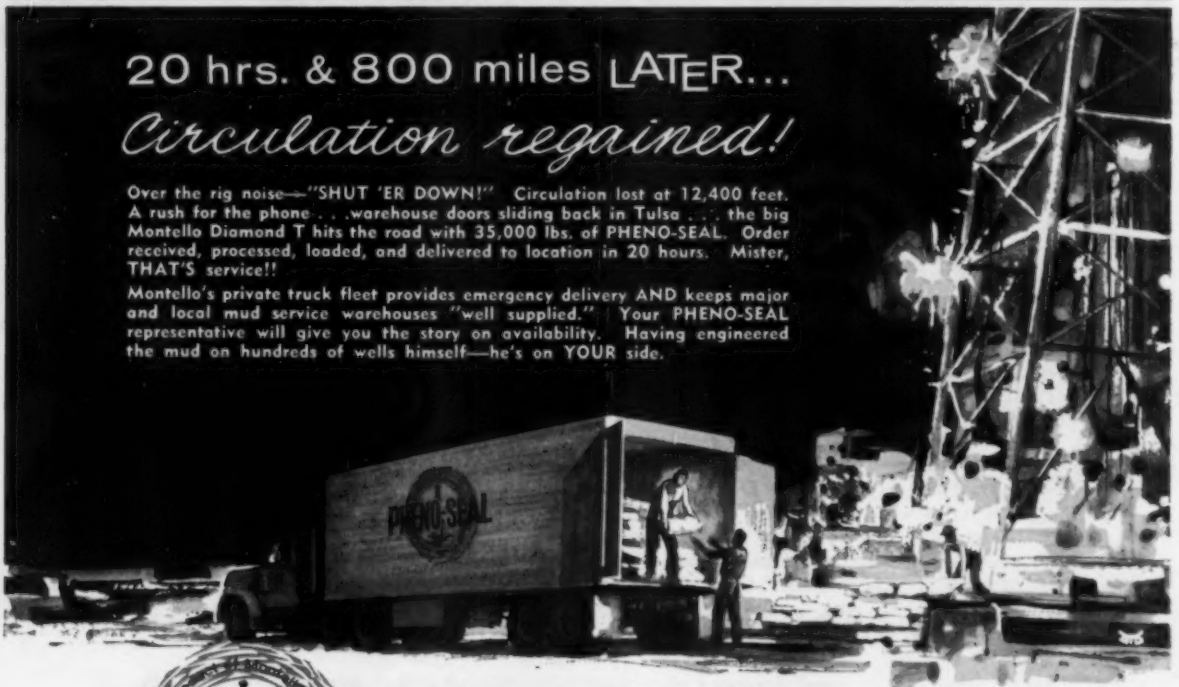
Biggest building program in 42-year history of Fred E. Cooper, Inc. has been completed at main plant in Tulsa, Oklahoma. Fabrication shop shown increases space 95% over old area, and greater overhead room handles largest Cooper rigs. Company performs final machine assembly in this building, speeded by operating new tools strategically placed to correlate work on all three assembly lines. Two heavy-duty traveling electric cranes with hook lifts of 20 ft have capacity and necessary control to easily handle heaviest loads with necessary precision. Other facilities increased include paint shop, 178% more floor space; repair and final assembly shop, 100% more floor space; and modern fire-proof masonry executive and accounting offices with accoustical fiber-glass ceilings, 89% more space.

20 hrs. & 800 miles LATER...

Circulation regained!

Over the rig noise—"SHUT 'ER DOWN!" Circulation lost at 12,400 feet. A rush for the phone . . . warehouse doors sliding back in Tulsa . . . the big Montello Diamond T hits the road with 35,000 lbs. of PHENO-SEAL. Order received, processed, loaded, and delivered to location in 20 hours. Mister, THAT'S service!!

Montello's private truck fleet provides emergency delivery AND keeps major and local mud service warehouses "well supplied." Your PHENO-SEAL representative will give you the story on availability. Having engineered the mud on hundreds of wells himself—he's on YOUR side.



PHENO-SEAL

MONTELLO, INC.
Box 5334 Tulsa, Oklahoma

Sales Representatives—

Pheno-Seal Sales Co.
McAllen, Texas ..... MU 6-3943
Lafayette, La. ..... CE 5-6945

Circulation, Inc.
Borger, Texas ..... BR 4-3033
Pampa, Texas ..... MO 4-2571

You will find PHENO-SEAL available through the nation-wide warehousing facilities of all progressive mud service companies.

distribution manager; **Myron Robertson,** assistant regional sales manager — Northern division.

Rector Well Equipment Company — **Frank A. Proctor Jr.,** assistant division manager for West Texas.

Western Company — **Dr. Ernest Dale,** Cornell University professor, **Charles S. Leonard,** president of Aurora Corporation of Illinois, **J. S. Brown, Roscoe C. Clark** —elected to board of directors.

National Tube Division of United States Steel Corporation—**Joseph B. Wilmering,** assistant manager — oil country tubular products sections.

Oil Well Supply Division of United States Steel Corporation — **Thomas M. Harvey,** manager — machinery sales, Calgary.

Houston Oil Field Material Company, Inc.—**W. H. Attlesey,** export sales representative formerly technical advisor to Petrobras in Brazil; **H. H. Hughes,** central division manager headquartered in Houston.

Security Engineering Division, one of the Dresser Industries — **K. L. (Ken) Byerly,** vice president-domestic sales; **John G. Orton,** vice president—export.

Ideco Division of Dresser Industries, Inc.—**Robert C. Hamilton,** treasurer and controller, formerly supervisor of banking division-finance and economics department of Texaco, Inc., in New York City.

General News

Corrosion Rectifying Co., Inc. of Bellaire, Texas, has instituted an expansion program designed to double the firm's gross of $500,000 in 1959 within a year. Wayne A. Johnson, founder and president, reports they will open a number of branch offices throughout the South and Southwest to answer the need for a fully diversified corrosion company for heavy industry.

National Supply Company has opened a new modern store in Lawrenceville, Illinois. Located on the main highway, it combines sales room, offices, warehouse, pump shop and loading dock, plus plenty of parking room, space for a pipe yard, pumping unit store and used equipment yard. L. B. Strange is manager. National has had a store in Lawrenceville since 1907.

Continental-Emsco Company's oilfield equipment facility in Houston set a new plant record with 1,000,000 manhours without a disabling injury from November 17, 1959 to June 21, 1960. The plant had as many as 1000 employees working three shifts a day during this period.

Kraloy Plastic Pipe Company, Inc. manufacturers of a complete line of polyvinyl chloride (PVC) pipe, valves and fittings for the oil industry, also serve gas distributors, general industrial applications. Clay H. Hess, petroleum industry sales engineer, operates out of the Dallas office, Robert R. VanDine, manager. The Dallas office maintains a complete inventory in addition to a sales and service force.

Lee C. Moore hosted a group of Colombian student during a three-day tour of the Tulsa manufacturing facilities and nearby oil fields. The students were from the Industrial University of Santander, Bucaramanga, Colombia.

Another plus value:

Use Seeco-Mul As A Drilling Soap and Bit-Lubricant, Too

If you've been dumping your wife's washing machine powder in the hopper and expecting it to do the job as a surfactant or bit lubricant in your drilling fluid, you may be twisting off.

Household soaps aren't as effective as you think they are. Besides, there's a better drilling soap — Seeco-Mul.

Also, Seeco-Mul is the best E-P lubrication agent you can run. So you get both, and save money, too.

So-called drilling soap and drilling detergent materials range from commercial, household detergents, which contain only about 15 per cent active surface tension reducing agent and 85 per cent water softener (such as soda ash, phosphates, etc.), to solutions of various fatty soaps and detergents in water. Some of these materials have no film-forming characteristics and actually dissolve whatever lubrication properties there are in the system away from the bit bearings and races. They also accelerate corrosion and pitting of the drill pipe and collars.

There are some lubricating qualities in such materials, but in order to achieve the concentration necessary to be effective in the system, the cost would be much more than any benefits derived from their use. Some of these solutions contain as much as 80 or 90 per cent water — yet cost as much as $4.00 per gallon. In dry form, this means that the active material could cost as much as $2.35 per pound, compared to less than 1/10 of that amount per pound for Seeco-Mul.

Seeco-Mul is often used as a drilling soap because it is one of the most efficient surface tension reducing agents available. It is a chemical emulsifier with superior wetting ability, and in addition Seeco-Mul is an effective extreme pressure lubricant.

The combined action of E-P lubrication and low surface tension not only affords greatly increased bit bearing life, but increases the penetration rate also. Since a tough, impervious film is formed on all metal surfaces, hydrogen-weakening (and subsequent failure) of bit bearings, drill pipe, and collars is practically eliminated. This protection is valuable in water containing hydrogen sulfide and other inorganic sulfides ("sulfur water").

Pound-for-pound and dollar-for-dollar, Seeco-Mul used as a drilling soap affords:

1. More effective E-P lubrication.
2. Faster penetration rate.
3. Larger cuttings.
4. Protection against corrosion and pitting of metal that comes in contact with the drilling fluid (especially valuable in sulfur water).
5. Lower surface tension.
6. Lower mud costs.

Seeco-Mul has a number of other operating advantages which your local mud dealer will be glad to tell you about — or write to us; we'll be glad to send you technical literature and a lab sample without obligation.

COMPARISON OF E-P PROPERTIES AND EFFECTS OF ADDING SURFACE TENSION REDUCERS TO TAP WATER — ½ GRAM ADDITIVE — 350 MLS. TAP WATER

Additive	None	Seeco-Mul	Soap "A"	Soap "B"
Description	—	Dry Flake	Water Solution	Water Solution
Concentration	—	½#/Bbl.	½#/Bbl.	½#/Bbl.
Surface Tension Dynes /CM, 25°C.	74	29	29	30
E. P. Test	Failed 25 In./Lbs.	Passed 400 In./Lbs.	Failed 90 In./Lbs.	Failed 120 In./Lbs.
Equivalent Timken Reading	10 Lbs.	97 Lbs.	38 Lbs.	49 Lbs.

Make a good mud better... use

CROSSETT **Seeco-Mul** DRILLING MUD ADDITIVE

Manufactured by the Chemical Division of The Crossett Company, Crossett, Arkansas

Seeco-Mul is the dried flake form of a compound of the sodium salts of abietic, linoleic, and oleic acids, together with quantities of wood tannins and lignins.

What's doing in DRILLING

Rotary Drilling Contract Revised for Bid Requests

American Association of Oilwell Drilling Contractors has revised its rotary drilling contract so that it may also be used as a bid request sheet. There has been a considerable number of requests for a bid proposal form to be used in conjunction with the contract form, the association reports.

The form will allow owners to submit identical requests for bids to contractors being considered, and to assure that the contractors are bidding on an identical basis.

In studying the need for the new form, the AADOC committee on contracts recognized that only a few changes in the present AADOC form would be necessary to convert it to a dual purpose instrument. The changes were made, and the board of directors of the association adopted it recently in Los Angeles.

Forms may now be obtained from the AADOC.

First Relocation Performed On Aluminum Drill Platform

First salvage and relocation job on an aluminum template offshore drilling platform in Lake Maracaibo has been accomplished. Salvageability has been one of the important features of the new-type platforms. But, until recently there had been no occasion to relocate this type structure.

Platforms were designed to overcome the problem of corrosion in Lake Maracaibo. Each single-well platform uses about 80,000 lb of aluminum.

First such structure was moved for Signal Oil & Gas Company of Venezuela.

In total time of less than one week, divers did preliminary work of cutting off steel pilings which anchored the platform, shot off conductor pipes, pulled the structure out of the water onto the deck of a derrick barge, made modifications on the structure to equip it for a different utilization, moved the platform to another location in the lake, and installed it ready for use.

Because these jobs had to be coordinated with Signal's operations, actual work on the project was not in progress all the time. With this initial experience, future jobs may require even less time.

Double Duty Rig Offshore Allows Drilling, Workover

A "double-duty" rig with which a crew can complete or workover one well while drilling another has been developed through cooperation of Loffland Brothers Company and The California Company for use offshore from Louisiana.

Installation of Loffland's Rig 130 and Rig 155, which are located 30 miles from shore in the Bay Marchand field. Supervisors and drilling crews are using the equipment to drill a total of 18 directional wells.

Unique arrangement allows the heavy-duty rig to change immediately from a completed drilling job to a new directional location. Smaller rig can then be put into service to complete the well just drilled or to perform workover jobs on other producing wells on the platform.

By having one contractor perform both drilling and completion work, the personnel have first-hand knowledge of the wells, supervisory personnel of one contractor can contribute maximum assistance to completion, and various problems of supply, transportation, and communications can be coordinated.

Rig 130, the drilling rig, is equipped with drawworks powered by four six-cylinder diesel engines of 460 hp each at 1200 rpm. There are two 700-hp slush pumps and a 500-hp auxiliary pump powered by a diesel engine.

Rig has a 500-ton traveling block, swivel, and 27½-in. rotary table. Six-well derrick is 156 ft high from floor to gin pole, and 142 ft from floor to top of crown.

Rig 155, the workover rig, has a 600-hp turbodiesel engine powering the drawworks.

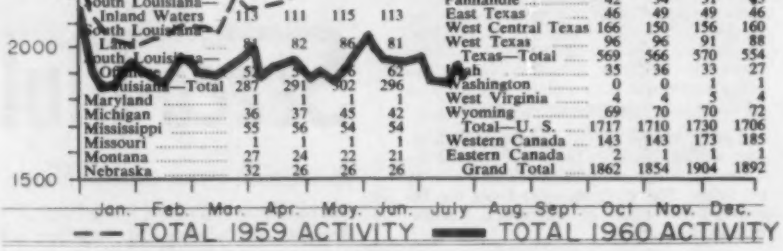
Mud tanks for drilling are located adjacent to substructure on the lower level of platform, along with production equipment. This includes surface control equipment, oil and gas separation vessels, metering equipment, and other items used to handle production from wells already completed from this platform.

Tender furnishes pipe and cement storage, crew quarters, emergency evacuation, and other uses. Mud tanks for the completion rig are located on the tender.

Rotary Rigs Operating in Oil Fields of United States and Canada

As reported to American Association of Oil Well Drilling Contractors by Hughes Tool Company.

	July 4	July 11	July 18	July 25		July 4	July 11	July 18	July 25
Alabama	4	3	2	3	Nevada	0	0	0	0
Alaska	4	5	5	5	New Mexico	108	102	106	107
Arkansas	12	13	12	11	New York	0	0	0	0
Arizona	0	0	0	0	North Dakota	15	17	17	15
California—Land	76	79	79	87	Ohio	6	4	5	5
California—Offshore	5	5	4	3	Oklahoma	174	167	167	160
Calif.—Total	81	84	83	90	Oregon	0	0	0	0
Colorado	27	29	31	34	Pennsylvania	11	8	11	10
Florida—Land	2	3	2	2	South Dakota	0	0	0	0
Florida—Offshore	0	0	0	0	Tennessee	0	0	0	0
Florida—Total	2	3	2	2	S. Tex. & Gulf C.—Inland Waters	5	6	5	5
Illinois	42	39	37	43	S. Tex. & Gulf C.—Land	161	177	183	164
Indiana	8	7	7	12	S. Tex. & Gulf C.—Offshore	2	1	1	1
Iowa	0	0	0	0	North Texas	51	52	54	47
Kansas	103	112	110	106	Panhandle	42	34	31	33
Kentucky	4	5	5	4	East Texas	46	49	49	46
North Louisiana	41	44	45	40	West Central Texas	166	150	156	160
South Louisiana—Inland Waters	113	111	115	113	West Texas	96	96	91	88
South Louisiana—Land	81	82	86	81	Texas—Total	569	566	570	554
South Louisiana—Offshore	53	54	56	62	Utah	35	36	33	27
Louisiana—Total	287	291	302	296	Washington	0	0	1	1
Maryland	1	1	1	1	West Virginia	4	4	5	4
Michigan	36	37	45	42	Wyoming	69	70	70	72
Mississippi	55	56	54	54	Total—U. S.	1717	1710	1730	1706
Missouri	1	1	1	1	Western Canada	143	143	173	185
Montana	27	24	22	21	Eastern Canada	2	1	1	1
Nebraska	32	26	26	26	Grand Total	1862	1854	1904	1892



The importance of Simplicity in a retrievable squeeze packer

Complexity is a retrievable squeeze packer's worst enemy. Simplicity of design is the best guarantee that the packer will do its job well and retrieve.

Simplicity and reliability go together in the Baker Full-Bore Cementer. This rugged tool is trimmed to fighting weight. It sets and packs off easily. It holds pressures from above or below, and does it with a tenacious grip. It retrieves easily.

Here's a tool so good it has changed everybody's ideas on how a squeeze packer should perform. Thousands of successful high pressure cementing, frac, and testing operations demonstrate its success.

THE BAKER SERVICEMEN who run the Full-Bore Cementer have two important things working with them and for you. They have professional skill in running Baker service tools, and in the Full-Bore they have a superior tool to run. The combination offers a dependability that's hard to equal.

BAKER FULL-BORE CEMENTER

Product 410-C

BAKER OIL TOOLS, INC. HOUSTON / LOS ANGELES / NEW YORK

Facts about a reliable squeeze tool

1 It is an important squeeze cementing tool. (Full Bore makes reversing out sand bridges easy; and allows re-perforation, when necessary, without a round trip with tubing.)

2 Ability to hold pressure from above or below makes it ideal for testing casing.

3 Optional Baker Model N Full-Bore Tubing Tester permits testing of tubing string in conjunction with operation of the Cementer.

4 The Cementer is an important tool for formation fracturing and high pressure acidizing. (Full Bore helps prevent sand screen-out when fracturing. On completion of frac or acidizing operation, tubing may be swabbed immediately, without having to reset the Cementer. When pressure reverses, opposite set of slips takes over automatically. Packing elements stay packed off, resist pressure from either direction.)

5 It is teamed with the Baker Retrievable Bridge Plug in straddle operations—either single-zone or selective multiple-zone. Together they can straddle a virtually unlimited interval. And: because both Cementer and Plug are so easy to pick up and relocate, any number of zones can be tested and treated in one round trip.

6 An unloader allows circulation above the Cementer, or equalization of tubing-annulus pressures, when desired.

7 The packer retrieves simply and easily. For added protection, two emergency release mechanisms are built-in.

Offshore Drilling Termed "Touch And Go" Operation

Drilling for the nation's offshore oil resources was termed a "touch and go" operation by Kenneth H. Crandall, exploration vice president of Standard Oil Company of California in a speech recently before the national convention of Petroleum Landmen.

Crandall pointed to the harmful procedures of some state and federal agencies and the current boundary disputes in the Gulf of Mexico as factors which have caused serious financial problems for companies engaged in exploration for offshore oil.

"The industry has poured billions into offshore oil," Crandall said, "but has realized only a relatively small return." He pointed out that restricted allowables had a critically depressing effect on offshore development, and stressed the need for more conservative offshore bidding practices by individual companies lest they tie up such large capital investments that they rule out the chance for future profits.

"The agencies involved," he said, "should recognize that the offshore oil industry needs allowables, spacing and production practices designed to minimize the amount of capital investment necessary for each bbl of oil produced. What we ask is the cooperation necessary to promote maximum offshore production at minimum costs."

Crandall used the 5500-acre Summerland, California lease held jointly by Standard and Humble as an example of the extremely high costs of offshore oil exploration and development.

He indicated expenditures on the site as of June 1 had totaled $25 million, which included a bonus payment of $7,225,000 to the state. In return, the two companies had achieved produc-

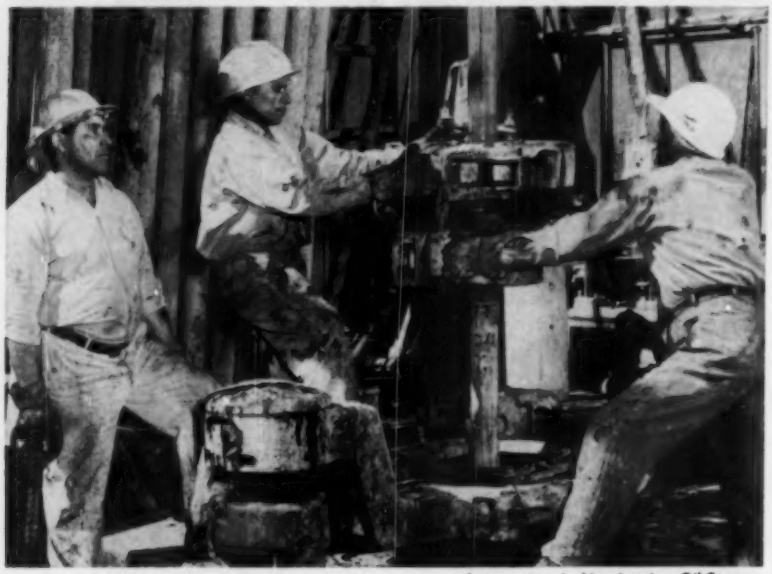


photo courtesy Arabian American Oil Company

Saudi Arab members of a drilling crew operate power tongs and power slips for Arabian American Oil Company. Saudi Arabs now constitute about 71 percent of Aramco's 16,257 employees in Saudi Arabia, and of these 76 percent hold semi-skilled, skilled and supervisory or professional jobs.

TWO HEADS ARE BETTER THAN ONE . . .

Except when it is a Hercules Type SOS Stripper Tubing Head.

This head is engineered to fulfill every field requirement for a medium pressure stripper tubing head. Its simplicity of design and ease of operation are outstanding features, and it consistently performs above recommended pressures, when needed.

But this head leads a double life. Remove the cap and the lower body section and put them together. You then have an SO Type Tubing Head that is compact and ideal for pumping a previously flowing well. **This is just one of many Hercules features that continuously give you more for your money.**

Write for Complete Information

HERCULES TOOL COMPANY
MANUFACTURERS OF OILFIELD EQUIPMENT
GENERAL OFFICES AND PLANT • TULSA, OKLAHOMA
Export Representative Oil Field Equipment Co., Inc. 90 West Street, New York, N. Y.

REDA PUMPS

FIRST CHOICE

FOR SECONDARY RECOVERY WATER FLOODING . . .

because pumping with REDA lowers costs and INCREASES PROFITS!

HERE'S HOW:

- Large water volume obtained from smaller size well casings reducing number of supply wells necessary
- Flexibility of Reda Pumps in meeting changing water requirements common to most waterflooding projects
- Easier, less expensive installation and lower maintenance costs
- Low operating costs and long operating life of Reda equipment
- Corrosion resistance of Reda pumps is superior to any other pumping unit used in supply wells

Reda Submergible Pumps are a major factor in the success of waterflooding and pressure maintenance operations. They are being used in major floods with very successful results of increased production and lowered costs.

Write for complete information today! Reda engineers will be pleased to call and assist in planning operations.

SIGN OF QUALITY . . SUBMERGIBLE REDA PUMPS

REDA PUMP COMPANY
BARTLESVILLE, OKLA.

tion of about 2400 bbl daily, but thus far have developed reserves of only moderate size. The state shares in all production at a royalty rate of 12.5 percent.

"While we are fortunate enough at Summerland to have a successful discovery being developed and produced under the best engineering practices, are favored with a low royalty rate, and are under no allowable restrictions, we may still be only swapping dollars," Crandall said.

"All this argues for a thoughtful approach by all parties to the many economic and operating problems we face offshore. It's largely a matter of accepting the fact that offshore work is unique and that changes must be made if the incentives of profit and payout are to be preserved."

Italy Expands Drilling With Third Mobile Unit

Italian government's fast-moving, state-owned oil company, ENI, has initiated plans for further expansion of its offshore oil drilling program by ordering a third mobile platform.

New self-contained platform will be identical to one purchased in February of this year which is now being assembled in Italy by Nuovo Pignone, an affiliate of Ente Nazionale Idrocarburi (ENI). Key components and technical guidance for the construction of both platforms will be furnished by a U. S. equipment company.

First mobile platform purchased by ENI in 1948 was a tender-assisted unit which was towed to Italy. It operated for a year drilling off the coast of Sicily and is now operating in the Adriatic Sea near Revenna, Italy.

The twin units will be constructed at Nuovo Pignone's plant at Massa on the north coast of Tuscany and at the nearby port of Marina di Carrara.

One platform will be used in the Persian Gulf, and the other is unassigned. ENI holds concessions in the Mediterranean, the Adriatic, and the Persian Gulf.

Advanced Course Planned In Drilling Engineering

An advanced drilling engineering course for the petroleum industry will be held at Texas A&M College this fall. Course may be taken in either of two complete sessions, the first being held from October 17 to 28, and the second from April 3 to 14, 1961.

Introduction will outline objectives of the course and the future of drilling technology. Course will include instruction on rocks; circulating fluids; drill strings; rotary drilling bits; crooked hole problems; controlled directional drilling; factors affecting rate

Another benefit of an Oakite ECP*

Chemical cleaning salvages more parts

Reclaim parts in volume by chemical cleaning—that's the specialized Oakite ECP way.

Move batch upon batch of rusty, mucky parts from scrap pile to warehouse...after a soak in the prescribed Oakite solution. No more hand chipping, scraping. Now you can strip paint from flanges and valves, descale pumps and pipes, handle all your cleaning problems swiftly and economically. Even the most difficult parts can be restored in less than 90 minutes.

****OAKITE ECP is a detailed Engineered Cleaning Program developed to fit your particular operation under the experienced supervision of your local Oakite man. ECP covers all your cleaning needs.***

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over 50 years' leadership in industrial cleaning
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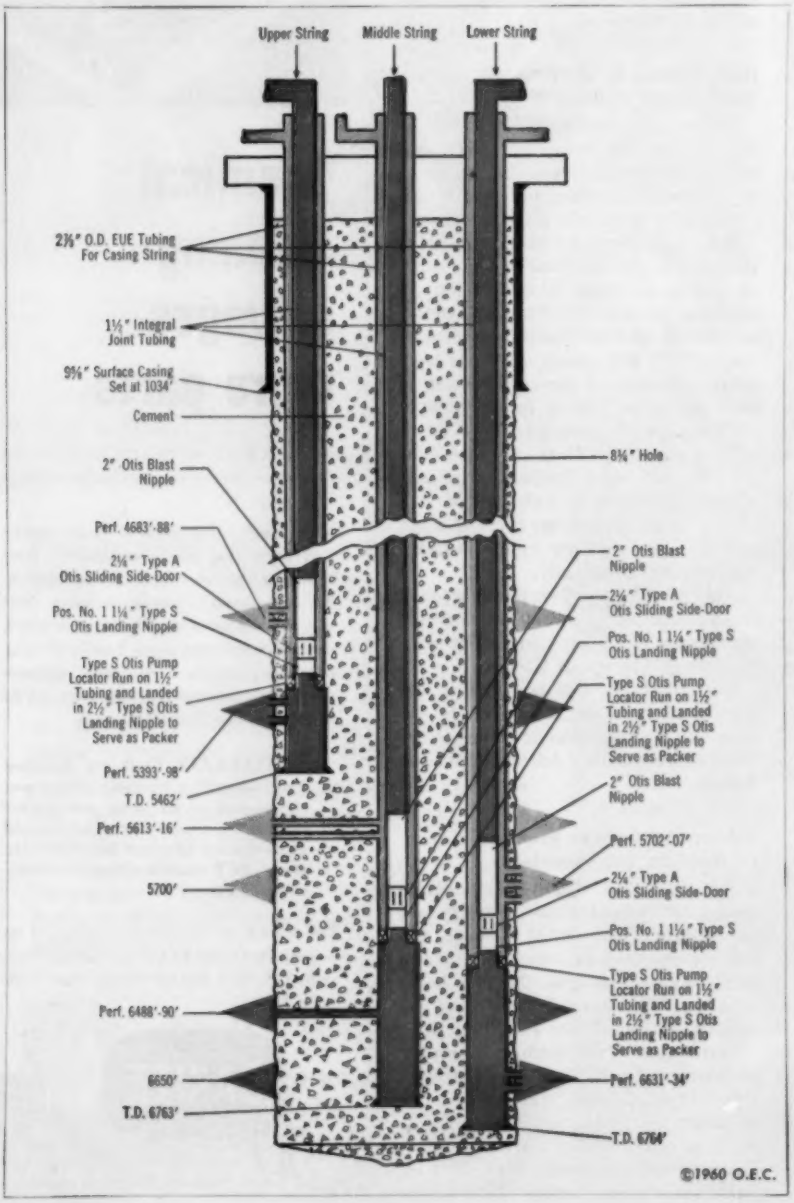
OTIS PRODUCTION NEWS

Volume I, Number 4 **Otis Engineering Corporation • Dallas** *Production Equipment and Services*

Otis Equipment Used Exclusively Below Tree in SUNRAY Sextuplet


Upper String
Middle String
Lower String
2⅜" O.D. EUE Tubing For Casing String
1½" Integral Joint Tubing
9⅝" Surface Casing Set at 1034'
Cement
2" Otis Blast Nipple
Perf. 4683'-88'
2¼" Type A Otis Sliding Side-Door
Pos. No. 1 1¼" Type S Otis Landing Nipple
Type S Otis Pump Locator Run on 1½" Tubing and Landed in 2½" Type S Otis Landing Nipple to Serve as Packer
Perf. 5393'-98'
T.D. 5462'
Perf. 5613'-16'
5700'
Perf. 6488'-90'
6650'
T.D. 6763'
8¼" Hole
2" Otis Blast Nipple
2¼" Type A Otis Sliding Side-Door
Pos. No. 1 1¼" Type S Otis Landing Nipple
Type S Otis Pump Locator Run on 1½" Tubing and Landed in 2½" Type S Otis Landing Nipple to Serve as Packer
2" Otis Blast Nipple
Perf. 5702'-07'
2¼" Type A Otis Sliding Side-Door
Pos. No. 1 1¼" Type S Otis Landing Nipple
Type S Otis Pump Locator Run on 1½" Tubing and Landed in 2½" Type S Otis Landing Nipple to Serve as Packer
Perf. 6631'-34'
T.D. 6764'
©1960 O.E.C.

CORPUS CHRISTI – Except for the tubing, all sub-surface production equipment used in the world's first sextuplet producer is standard Otis equipment. And the amount of Otis equipment used in this unique completion is surprisingly small in number and total cost; for example: Only two selective Type S Otis Landing Nipples, one Type S Otis Pump Locator which serves as a packer, one Type A Otis Sliding Side-Door®, and one Otis Blast Nipple were required for each two zones completed. The identical equipment was installed in each of the three strings of 2⅜-inch tubing to permit the six zones to be produced simultaneously and economically.

Otis is the only company which has available a complete range of small diameter sub-surface production equipment to help today's aggressive producing companies complete their slim hole and tubingless wells in the simplest manner. Otis Sub-surface Safety Valves, Sliding Side-Doors, Concentric Gas Lift Valves, Plugs, Plug Chokes, Pack-off Assemblies, and time proven wire line tools make it possible to complete as many zones as practical in the deeper, multi-zone wells being drilled today.

Otis Completion Specialists are available twenty-four hours a day to counsel with you on any specific completion problem. These men are expert in their field and backed up by the complete engineering and development laboratories in the Otis Dallas plant. For complete information on Otis sub-surface production equipment to be used in slim hole and tubingless completions, call the Otis office nearest you or write Otis, Dept. 4-P, Box 35206, Dallas 35, Texas. You'll find experienced Otis Well Completion Specialists ready to help you – anxious to serve you.

OTIS

Engineering Corporation

General Offices:

6812 Denton Drive • Dallas, Texas

of penetration; factors affecting hole oversize, sloughing, uniformity of wall and differential sticking of drill pipe; design and selection of various component parts of the drill string, and optimum conditions for rock penetration.

Course will conclude with operations associated with drilling, drilling economics, and methods of reducing drilling costs.

Registration cost is $250, and registration will be handled by Robert L. Whiting, Petroleum Engineering Department, Texas A&M College, College Station, Texas.

Firefighter Uses Soda In Killing Blowout Fires

Ken W. Casey Company has developed a new technique for putting out fires resulting from blowouts on gas wells. One or more machines blow bicarbonate of soda directly at the wellhead at the rate of 100 lb per sec.

Method of snuffing out raging inferno of a gas fire differs drastically from usual methods, which involve nitroglycerin explosions.

Ken W. Casey, owner of the three-man company, has machinery that is adequate to handle fires with a gas flow of up to 50,000,000 cu ft per day. On bigger flows he would use nitroglycerin.

Using four of his soda-blowing devices manifolded into one unit, he has extinguished a fire with from 15 to 20,000,000 cu ft of gas per day sending a tower of flame upward. Operation only took five seconds, he said, but the hardest thing is getting the well under control after the fire has been extinguished.

Casey recently moved to Midland, Texas, from the Gulf Coast.

New Tubular Service Uses Ultrasonic Inspection

A new oil industry inspection company specializes in ultrasonic inspection of oil field tubular goods. International Inspection, Inc., has been formed as a subsidiary of Welex, Inc., offering the Triple Eye service.

System employs the basic principles of pulse-echo ultrasonics to detect flaws. Development of focused ultrasonic transducer allows a hairline width of ultrasound to be focused on surface of tubular goods. This focusing effect permits measurements of wall thickness and detection of tiny flaws.

New Offshore Structure Allows Drilling 4 Wells

Four wells can be drilled from this new type protective structure which will soon be used by Shell Oil Company in offshore operations. Two wells would be drilled through front legs of device, and other relatively new ideas incorporated in the structure include the triangular shape and heavy skirt plates for protection from lateral wave forces.

I. C. Pognowski, shown with the device, designed the structure for use in water depths of 65 to 70 ft in Shell's

South Pass Block 27 field at the mouth of the Mississippi River.

Structure will be 116 ft in height and its four piles will be driven to a penetration of 405 ft below mud line.

No-Wall-Stick Drill Collars

The surface area of these drill collars has been changed to reduce wall contact area by more than 40%. Weight loss of the drill collar is only about 4%. Reduction of 40% in contact area results in a proportionate decrease in the total sticking force due to differential pressure of 40%. This design also gives a section of pressure equalization each foot along the body of the drill collar.

Three sizes (6", 4¾", 4⅛") of NO-WALL-STICK DRILL COLLARS are available on a rental basis in the Texas and Louisiana Gulf Coast area. Rental price of these NO-WALL-STICK DRILL COLLARS is very competitive to conventional drill collars run with stabilizers.

Any new or used drill collars, regardless of size, owned by Drilling Contractors or Oil Companies may be converted to NO-WALL-STICK DRILL COLLARS for a fixed conversion charge.

NO-WALL-STICK DRILL COLLARS offer far more protection from wall sticking in high angle holes or holes which have shale wash outs than drill collar strings using stabilizers.

NO-WALL-STICK DRILL COLLARS will not ball up, will not peel off wall cake, and may be sealed off by a Hydril type blow out preventor at any point.

Patent Pending.

No-Wall-Stick Drill Collars

effectively reduce sticking of drill collars

This new drill collar design has been expressly developed to combat the problem of differential pressure sticking of the drill collar string in the hole. It is a direct step in materially reducing the total sticking force.

Please write Houston office for descriptive brochure and price schedules

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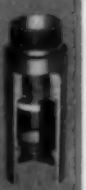
No-Wall-Stick Drill Collars may be handled through your local rental tool company.

Let R-u-b-b-e-r Take The Wear

in your sucker rod pumps

IT COSTS YOU LESS THAT WAY



● MARTIN RUBBER & DUCK RINGS give excellent life in dirty abrasive fluids . . . high or low gravity . . . much or little water . . . shallow or deep wells. They last for years in the easier pumping wells. Replacement rings cost comparatively little.

● MARTIN PLUNGER BODIES, precision grooved, drilled and threaded (no underneath fluid passage), usually last for years. Tube or barrel costs are often cut in half.

● The replaceable SYNTHETIC RUBBER GUIDES in MARTIN CAGES last longer than any metal, and the cushioning of the ball increases your ball & seat life. Results are often truly amazing. (Patent No. 2,591,174)

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New Literature

Sub-Surface Controls

A brochure from Camco describes the new Magnaset method of landing and locking sub-surface controls selectively in any one of a series of full opening, magnetically coded nipples. A selector tool with twin magnetic sensing elements automatically locates and locks the sub-surface control in the desired nipple in the tubing string. Features, uses, tool operation, and landing nipple construction are described. Engineering drawings of the locking devices and controls that may be set by the methods are also included. *Camco, Inc.*

Circle number (34) on reply card.

Tubing Safety Valve

Features, construction, operation, and servicing procedures of a new sub-surface tubing safety valve are included in an engineering brochure from Camco. Step-by-step outlines of methods for calculating valve settings for both oil and gas wells are presented. Example problems are also solved to illustrate the calculations. *Camco, Inc.*

Circle number (35) on reply card.

Orifice Fittings

Daniel Orifice Fitting has published a revised, 36-page edition of Catalog Section A on Senior orifice fittings. Fitting is a double-chamber fitting which allows changing of orifice plates without line shut-down or by-pass.

Included in catalog are parts illustrations which show new equalizer valve and stuffing box, and complete installation, operation, and maintenance instructions for fitting. They are available from 2-in. to largest line size and in A.S.A. pressure ratings of 150 to 2500 lb. Standard trim is 316 stainless steel. *Daniel Orifice Fitting Company.*

Circle number (36) on reply card.

Wire Rope Slings

Comprehensive 4-page folder, Bulletin DH-425, covers new American Chain & Cable high carbon steel strand-laid wire rope slings. Construction details, advantages, rated capacities of the slings with a safety factor of 5 to 1, are listed and tabulated. *American Chain & Cable Company, Inc.*

Circle number (37) on reply card.

Handling Oilfield Brines

A study by the Research Committee of the Interstate Oil Compact Commission entitled, "Production and Disposal of Oilfield Brines in the United States and Canada", has been completed and is ready for distribution. This is the first publication of this type that has been prepared. *Interstate Oil Compact Commission.*

Circle number (38) on reply card.

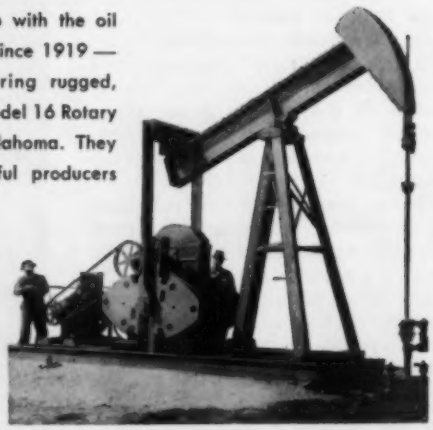
Drilling Mud Additive

Crossett has published a technical bulletin, No. S-1, on Seeco-Mul, a drilling mud additive and emulsifying agent. Bulletin discusses lubrication characteristics of drilling mud fluids, with special emphasis on extreme pressure lubricating properties of mud additives. *Crossett Chemical Company.*

Circle number (39) on reply card.

ALWAYS DEPENDABLE

JENSEN JACKS have grown up with the oil industry. For over 40 years — since 1919 — JENSEN has been manufacturing rugged, dependable jacks like this big Model 16 Rotary Balanced Unit operating in Oklahoma. They cut operation cost for successful producers wherever oil is found.



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Safety-Relief Valves

A 28-page liquid relief and special service safety-relief valve catalog, in color, has been published by Farris Engineering. Catalog describes and illustrates complete Farris line of safety-relief valves for marine service, fire pump service, hydraulic pressure systems, and other uses. *Farris Engineering Corporation.*

Circle number (40) on reply card.

Emulsion Hydraulic Fluids

A technical bulletin on water-in-oil emulsion hydraulic fluids is available from Atlas Powder. Bulletin contains typical emulsion formulations as well as composition for low viscosity emulsion fluids and formula for an emulsion to be used in high temperature operations. *Atlas Powder Company.*

Circle number (151) on reply card.

Cable Tool Drills

Complete line of Speedstar cable tool drills is described in a 12-page bulletin available from Buffalo-Springfield. Detailed descriptions are given of four compact models, including photographs and specifications. It lists optional equipment and discusses rotary attachments available to convert them into a combination rotary and cable tool rig. *Buffalo-Springfield Company.*

Circle number (152) on reply card.

Anti-Fouling Agent

Anti-fouling agent designed to prevent severe organic fouling in naphtha and gas oil streams is described in a two-page bulletin available from Nalco.

Literature points out that additive can also be used in cases of organic fouling in reboilers or distillation columns, or for preventing build-up of polymeric type deposits on exchanger tube walls. Physical characteristics, dosage, and effect on catalysts are covered in Nalco Product Bulletin G3-262. *Nalco Chemical Company.*

Circle number (153) on reply card.

Liquid Metering Terms

A glossary of terms used in liquid metering has been prepared by Howard E. Rittenhouse, chief engineer, petroleum and industrial liquid meters, with Rockwell. Glossary clarifies commonly-used terms applied to meters. *Rockwell Manufacturing Company.*

Circle number (154) on reply card.

Mud Systems, Components

A 6-page bulletin covers complete mud systems and their components. It shows specialties in gate valves, check valves, a variety of steel mud pits, and considerable information as to usual arrangements and operation of equipment. *Joe Stine, Inc.*

Circle number (155) on reply card.

Unit Pumpers

Booklet describes full line of Continental-Emsco unit pumpers, including seven recently-added sizes. It contains rating charts, dimensions, and specifications. Illustrations include new design features, one-man counterbalancing method, and typical prime mover mountings. Information on load multiplication factor and its effects on power costs and wear is included. *Continental-Emsco Company.*

Circle number (156) on reply card.

Cementing Equipment

Brochure on new equipment for cementing jobs using the controlled slurry cementing techniques is available from Dowell. Cement transport truck, blender control panel, heavy-duty cementing unit with two pumps, and process of controlled slurry cementing are described. *Dowell Division of Dow Chemical Company.*

Circle number (157) on reply card.

Engineering Index

A new edition of The Engineering Index containing 1600 pages is available. It is a guide to the current technological literature of the world for 1959. Edition will contain over 30,000 annotations selected from over 1600 technical publications published throughout the world. It is edited by a staff of qualified editors who review articles concerning application of engineering methods and concepts in every phase of the economy. Information is indexed under 249 divisions of engineering. Catalog free on request outlines coverage of each of these divisions. *The Engineering Index, Inc.*

Circle number (158) on reply card.

Lightweight Gas Turbine

"New Dimensions in Lightweight Gas Turbine Power," bulletin GEA-7083, 8 pages, introduces General Electric's family of 75 to 20,000-hp ultra-lightweight, compact gas turbines designed for a wide variety of applications. This includes fluid and gas pumping, electric power generation, and marine and vehicular propulsion. Described are design features, performance and operating characteristics, plus current and potential applications for the 900-hp Model 720/722 and 20,000-hp Model 240 gas turbine. *General Electric Company.*

Circle number (159) on reply card.

Chains and Sprockets

Stock sizes of Link-Belt roller chains and sprockets, available for immediate delivery in every major industrial area, are conveniently listed in a new 44-page book, No. 2757.

Book lists over 2000 types and sizes of stock roller chains and sprockets, including standard and double pitch power transmission chains, a large selection of conveyor chains and attachments, and the company's complete line of sprockets.

An 18-page section lists stock sizes of standard roller chains and heavy series roller chains, corrosion-resistant stainless

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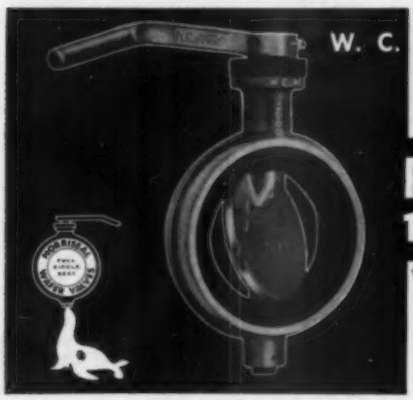

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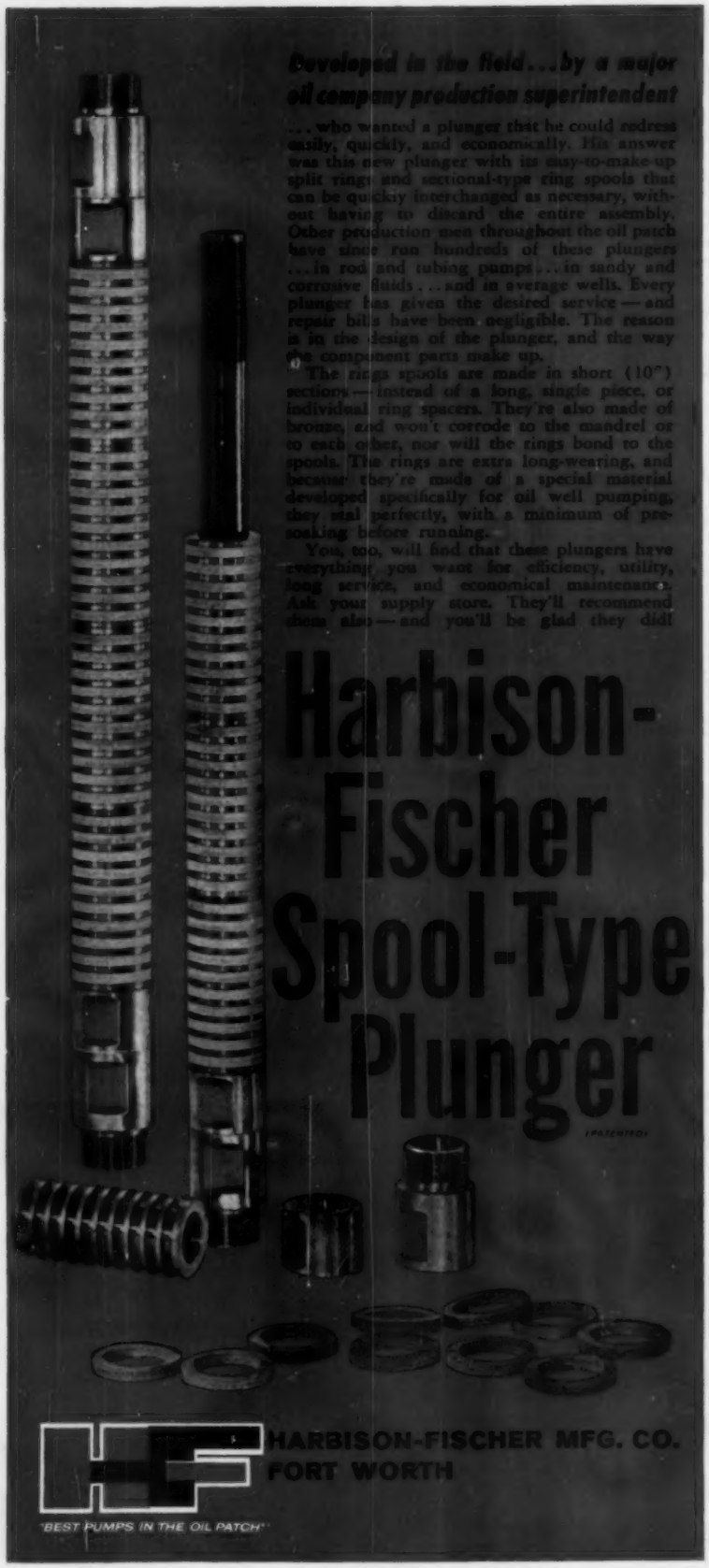

Developed in the field...by a major oil company production superintendent
...who wanted a plunger that he could redress easily, quickly, and economically. His answer was this new plunger with its easy-to-make-up split rings and sectional-type ring spools that can be quickly interchanged as necessary, without having to discard the entire assembly. Other production men throughout the oil patch have since run hundreds of these plungers ...in rod and tubing pumps...in sandy and corrosive fluids...and in average wells. Every plunger has given the desired service — and repair bills have been negligible. The reason is in the design of the plunger, and the way the component parts make up.
The rings spools are made in short (10") sections — instead of a long, single piece, or individual ring spacers. They're also made of bronze, and won't corrode to the mandrel or to each other, nor will the rings bond to the spools. The rings are extra long-wearing, and because they're made of a special material developed specifically for oil well pumping, they seal perfectly, with a minimum of pre-soaking before running.
You, too, will find that these plungers have everything you want for efficiency, utility, long service, and economical maintenance. Ask your supply store. They'll recommend them also — and you'll be glad they did!
Harbison-Fischer Spool-Type Plunger
HARBISON-FISCHER MFG. CO.
FORT WORTH
"BEST PUMPS IN THE OIL PATCH"

steel and bronze roller chains, double pitch roller chains, various types of flat-top conveyor chains, and leaf chain.

Sprockets described in a 20-page section include finished bore, taper lock, mandrel bore, type D (removable segments) and shear pin types. *Link-Belt Company.*

Circle number (120) on reply card.

Continuous Dipmeter Broadened Application

Schlumberger continuous dipmeter's broadened application is described in Engineering Report No. 8. The instrument also is described in evaluating its use in the increased number of dipmeter surveys being conducted for obtaining more detailed geological information. Booklet may be obtained from field offices or the sales office in Houston. *Schlumberger Well Surveying Corporation.*

Circle number (116) on reply card.

Kansas Oil Map

A geological pay formation map covering Morton, Stevens, Grant, Stanton, Hamilton, and Kearney Counties in Southwest Kansas has been published by Interstate Development Maps. Size is 40 in. by 60 in. and scale is 1 in. to 8000 ft.

It is the only geological pay formation map yet drafted on the area, and it is large enough to show all wells, both producers and failures. Operator and fee is shown on all producers and field names are printed adjacent to actual producing area described. Coded symbols are used to designate producing horizons of each well and a stratigraphic section with the code is printed as part of each map. *Interstate Development Maps.*

Circle number (117) on reply card.

Derrick Lighting

An 8-page publication designed to serve as a ready reference to assist an operator in selection of derrick lighting systems and components has been published by Hutchison, manufacturer of Flolight vapor-tight derrick lighting systems.

Reference guide represents first bulletin of its kind. User is given complete, detailed information as to exact type of light or component needed.

Publication covers systems and components for all derricks and masts. *Hutchison Manufacturing Company.*

Circle number (118) on reply card.

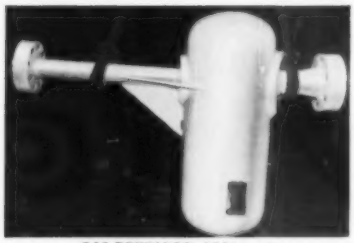
Bronze Gate Valve

A four-page, two-color circular describing the Union Bonnet bronze gate has been published by Lunkenheimer. Sectional views detail features of the valve, and a table of dimensions also is included. Available in sizes ¼ to 2 in., the valve has a double wedge disc and rising stem. It is rated 125 lb s.p. to 200 lb w.o.g. *The Lunkenheimer Company.*

Circle number (119) on reply card.

CORRECTION

The article appearing on page B-31 of the July 1960 issue under the title "New Developments in Nuclear Logging" by John C. Stick Jr., should have been titled "Nuclear Radiation Logging of Wells." This article was adapted from one of a series of lectures presented at a senior seminar in petroleum engineering at the University of Texas.



GAS PRESSURE, 1500 p.s.i.

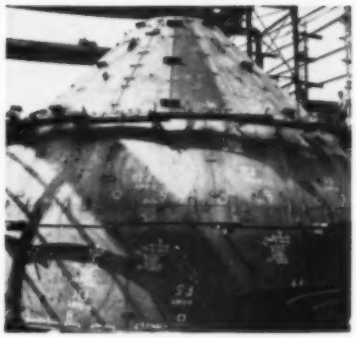
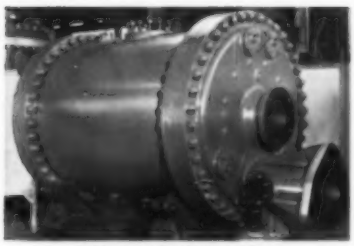


PLATE WORK, 55′ dia. cone

GALVANIZING POT

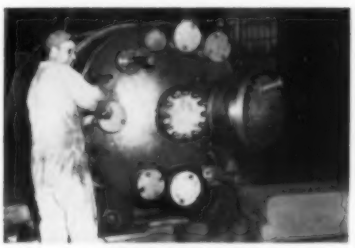
SPECIAL ALLOY STEEL DEFLECTORS



SPECIAL CHEMICAL VESSEL

SPECIAL STAINLESS VESSELS

TOWER, 8′6″ dia. x 154′ in length



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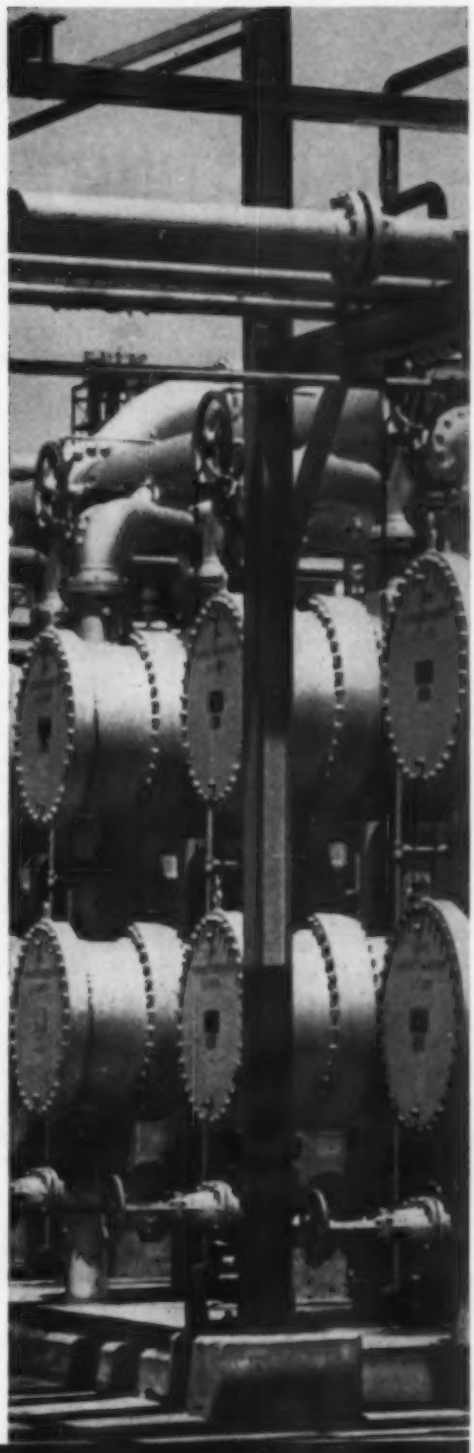

Exchangers at Cat crackers "A" and "B" were both running fractionater bottoms through the tubes as well as gas oil on the shell side. The tube sides were OK, but shells became fouled with carbonized oil. The four tube bundles on "A" Cat were pulled and vat cleaned. Results: excellent. Cost $2730.

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PREDICTING ROAD PERFORMANCE OF FUELS IN 1960 CARS

Ethyl Research Develops New Coefficients for Road Rating Equations

by **H. J. SEWELL,** *Refinery Technology Division, Ethyl Research Laboratories, Detroit, Michigan*

Data on the road performance of gasolines are essential for selecting the most economical processing or additive route to produce the fuel antiknock quality that will meet the changing needs of the car population. There is little doubt that road tests provide the best yardstick for measuring the ability of gasolines to satisfy individual cars and the car population. However, road testing is both costly and time-consuming.

To help refiners save time and money, Ethyl developed a now widely accepted procedure for calculating road octane performance from routine laboratory test data. Now Ethyl has computed new equation coefficients with which road ratings may be calculated for 1960 cars, using both the Modified Uniontown and Modified Borderline methods. Coefficients have been developed for road ratings during part-throttle operation as well as at full-throttle.

Here's The General Equation

The relationship of road performance to laboratory variables is expressed in the following equation:

$$\text{Road ON} = a + bR + cM + dO$$

where R = Research octane number
M = Motor octane number
O = Olefins, vol %

a, b, c, and d are equation coefficients for particular cars and tests. The coefficients for premium gasolines based on ratings in four 1960 premium-fuel cars are shown in Table I.

Since the antiknock effect of TEL is greater on the road than in the laboratory, it follows that adding a TEL factor to the general equation significantly improves predicting accuracy. These new coefficients are shown in Table II.

Use of the Equations

Experience with these equations has shown that they are useful in calculating road performance of fuels that are similar in antiknock quality and hydrocarbon composition to those used in the development program.

Since a wide range of full-boiling commercial gasolines was used to develop the Ethyl equations (Table III), they can be used for almost all current gasolines.

Although road octane numbers assigned to gasolines by one vehicle are not necessarily reproducible in other vehicles of the same make and model, experience has shown that *relative* fuel ratings are consistent from car to car.

Ideally, therefore, the equations should be used to *compare* the road performance of gasolines rather than to obtain the road octane number of a specific fuel. In fact, the same reasoning also applies to experimental road-rating results.

Many refiners have found these equations useful in:

1. Analyzing the effects of laboratory properties on road performance when designing current motor fuels;

2. Predicting future trends in the road performance of motor fuels.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

TABLE I

Equation Coefficients for Premium Fuels (4-Car Average)

Road ON = a + b(RON)+c(MON)+d(% Olefins)

		a	b	c	d	Stand. Error
Modified Uniontown		37.081	0.268	0.391	–0.041	0.59
Modified Borderline	2000 rpm	24.673	0.473	0.316	–0.020	0.61
	2500 rpm	24.966	0.457	0.319	–0.036	0.66
	3000 rpm	24.738	0.381	0.394	–0.059	0.76
	3500 rpm	16.257	0.345	0.517	–0.079	0.84

TABLE II

Equation Coefficients for Premium Fuels, TEL Factor included (4-Car Average)

Road ON = a + b(RON)+c(MON)+d(% Olefins)+e(ml TEL/gal.)

		a	b	c	d	e	Stand. Error
Modified Uniontown		42.942	0.273	0.313	–0.048	0.289	0.53
Modified Borderline	2000 rpm	31.851	0.479	0.221	–0.028	0.354	0.51
	2500 rpm	34.266	0.465	0.195	–0.046	0.484	0.53
	3000 rpm	34.341	0.389	0.266	–0.070	0.474	0.65
	3500 rpm	25.702	0.353	0.391	–0.089	0.466	0.72

TABLE III

Full-Boiling Premium Fuels Used To Develop Coefficients

Variable	Range	Average
Research Octane Number	96.7—104.3	100.4
Motor Octane Number	84.2—97.1	90.6
Aromatics, vol %	7—57	27
Olefins, vol %	1—46	20
Saturates, vol %	34—87	53
TEL, ml/gal	2.0, 4.0	

How Ethyl Research can help you

Three publications that will enable you to calculate gasoline road performance from laboratory test data are available:

1. "Road Octane Correlations for Premium Gasolines, 1960"
2. "Road Octane Correlations for Regular Gasolines, 1960"
3. "Part-throttle Road Octane Correlations for Premium Gasolines, 1960"

Copies of these reports are available from your Ethyl Representative, or by writing Ethyl Corp., 100 Park Ave., New York 17, N. Y.

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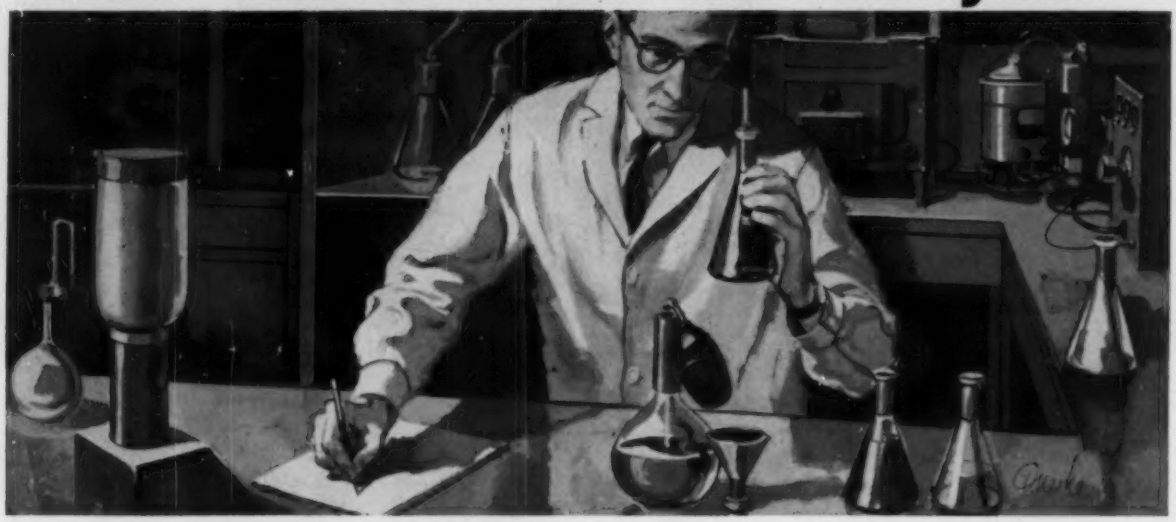

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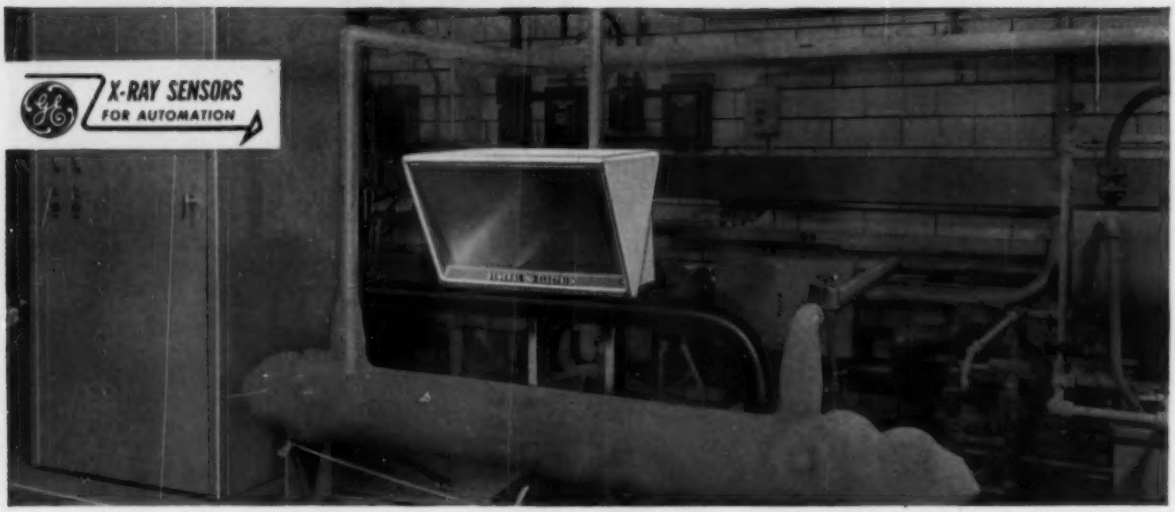

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The unit can generate 138,000 lb of steam per hour at 300 psig and 540 F. The boiler can operate on oil plus combustibles in the cat cracker regenerator flue gas, or on oil alone.

The CO Boiler was installed to take care of increasing steam requirements. The sensible heat of the waste regenerator gases was already removed with an existing waste heat boiler. Selection of a CO Boiler over conventional steam-generating equipment was made to utilize the waste combustible heat from the 17,500 bbl/D fluid unit, and to utilize existing manpower.

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DR. D. Q. KERN
D. Q. Kern Associates
Cleveland, Ohio

A challenge for the process designer

"An engineer can attempt to assemble a plant fulfilling contracted availability and incorporating current procedures, but he will be remembered more as a sport than a designer."

WHEN BUYING new petro/chem facilities, there is an increasing tendency for processors to request that an "availability factor" be incorporated into the performance guarantee. Definitions for this factor vary from contract to contract and one of them is *"the minimum percentage of a year's hours during which a facility shall produce the equivalent of rated capacity."* The year starts on some fixed date after the conclusion of construction or going on stream and could conceivably extend for several years thereafter.

Turnaround, preventive and emergency maintenance, and sometimes even production decline, coincident with continuing operation, are guaranteed by the contractor not to exceed that possible in the remainder of the time. The procurement procedure possesses little substance at the present time since it is rife with conditional and indefinite clauses which are difficult to enforce.

There is no published format for designing, assembling, and operating this wondrous plant. The whole idea seems to have originated in vocabulary rather than technology.

While dressing-up contract terms for such a plant, someone at some time failed to distinguish between single and double negatives. As a result, Contractor C sold Processor P a facility he had no way of rationally designing and leaving P uncertain of the size of the package he bought. P's dilemma is compounded by the fact that the same design procedures used by C are also used by P and do not have an availability factor in the ground rules.

When based on sound process design procedures and mutually acceptable conditions of risk, the availability factor could prove extremely valuable to the processor and contractor alike. It relates process design and process production on an annual basis and could focus attention on areas which sorely need review and modernization.

Some questions would be raised . . .

How much does a turnaround cost?

Why can some units operate for only three months and others three years?

What design changes make the cycle adjustable and by how much?

How much does a turnaround wear out plant components?

How does replacement cost change with successive turnarounds?

An engineer can attempt to assemble a plant fulfilling contracted availability and incorporating current procedures *— but he will be remembered more as a sport than a designer.* If the plant meets its guaranteed availability, it must be credited to luck. The cards are usually stacked in favor of buyer P when he is spending money. But in any situation influenced by luck, it must also be conceded that C received his share when he was awarded the contract while the goal posts were still shifting.

This last comment hinges on the fact that in a number of petro/chem processes, a facility can be offered with greater availability simply by increasing the extent of overdesign. Overdesign naturally makes some or all of the losses due to downtime recuperable. But overdesign raises the selling price. Since the availability factor cannot be pre-demonstrated by any existing procedures, Contractor C apparently knew when to stop stretching his luck.

Take a case in which P sent out an inquiry with a perfectly feasible availability factor of 95%. Whatever the capacity of the plant, there is only 5% of it with which the design group,

comprising the process engineers and project engineers, can play. The plant must be predicated on process and equipment design data which are accurate within 15 or 20% at best when enthalpy, equilibrium, efficiency, design, and control discrepancies are confounded. After considering a spectrum of nasty and nice experiences, it is questionable that the project engineer can estimate precisely the behavior of a plant's first few years with the small portion he gets of that same 5%.

The result . . . beef-up the plant and play it safe. If other endeavors followed this approach, the first satellite would still be a long way from launching. How many petro/chem facilities remain unlaunched for lack of an effective investment payload?

Today, the availability factor is really a guess based upon collateral experiences. Like most chance systems it leads to bigger and bigger chances which in time become costlier and costlier to buyer and vendor alike.

Here is the challenge: If guaranteed availability is really a trend, why not treat it as a science rather than a system of hunches. Many of those steady-state, hoary and respected design principles which repose in the *Bulky Big Black Data Book* have to go.

Who's to lead the change? The process designer. The uniform running hour or day is the basis of his design, and every hour or day of a plant's future is pretty much the same to him. When process and project computations are completed, they become a matter of record rather than a measure of reality.

The plant operates differently. To the operating staff every hour differs at least a little from its predecessor if for no other reason than that it must be added to it. There is a little more erosion, corrosion, wear, dirt, and calibration error which must be taken into account.

The process design engineer must establish the variable parameters which enable him to design a plant in the manner in which it will operate. Not for just the first hour or day, but for a substantial part of its life history.

Process design obviously must know a great deal more about the behavior of a plant to impose unsteady-state operations on steady-state design. Obviously, a large part of the procedure will depend upon statistical or analytical information obtained through **a healthy feedback** of operating and maintenance data. This regretably has been a weak link in the design/operations/maintenance sequence. Some petro/chem organizations, and large ones are included, simply have no one authorized to disseminate plant operating data. Except in cases of defective performance, there is no way of measuring the general level of under or overdesign.

Another problem is also present. The data required for statistical and analytical analyses are not necessary for the operation of the plant. It is improbable, for example, that a processor will add any great deal of extra instrumentation simply for the sake of research.

Any big stride is hard to sell. To this end the design group must cope with the humanistics and resistances basic to the situation. It can develop and expound the values of a breakthrough in current and so-called steady-state process design procedures. When incisive people inquire after this information, the design group must be prepared to state its case in a forthright fashion. It's an uphill struggle all the way — yet it will provide imaginative process designers with endless satisfaction — and the Hydrocarbon Process Industry with more rationally conceived plants.

"Many of those steady-state, hoary, and respected design principles which repose in the 'Bulky Big Black Data Book' have to go."

DR. DONALD Q. KERN heads D. Q. Kern Associates, a thermal design and application organization headquartered in Cleveland. From 1943 to 1953 he was professor of chemical engineering at Polytechnic Institute of Brooklyn, specializing in advanced instruction in process thermodynamics and heat transfer. Concurrently he served eight years as a department manager with Foster Wheeler Corporation. Kern, who studied at Massachusetts Institute of Technology and Brooklyn Poly, is author of the popular text *Process Heat Transfer*, now in its eighth printing.

"Some petro/chem organizations, and large ones are included, simply have no one authorized to disseminate plant operating data."

Design for lower

E. B. ASMUS, *Central Maintenance Engineer*
Sinclair Refining Company, Harvey, Illinois.

ONE AMBITION of every maintenance engineer is to participate in the design and selection of the maintenance facilities for a completely new refinery where space limitations, present practice and facility restrictions, etc., are not controlling factors. On such a job, new methods and new equipment can be employed to full advantage in developing an optimum design with respect to maintenance and capital cost. For the average maintenance engineer, this ambition is never realized; however, most maintenance people are positive that, given such an opportunity, they could economically reduce maintenance costs by a good, healthy percentage.

But one must be practical and face the fact that this opportunity will only come to a few. The more commonly occurring opportunity to contribute to lower maintenance costs, engineering-wise, occurs when a new processing unit is added to an existing plant. To do this, one must be completely alert to the restrictions that exist and work around them to the best advantage. A good maintenance engineer should be able to blend the old with the new and incorporate such maintenance cost-reducing features as can be economically justified. The resulting blend or compromise may fall short of meeting the most desirable modern approach but should be a step in that direction and a real improvement. One successful approach to achieving a lower cost maintenance design is through constant review and revision of company specifications and standards that are used in the design of the unit. Inclusion of desirable maintenance features at this point is practical and the least costly of several possible approaches. It is prohibitively expensive to correct a "poor design for maintenance" after the unit is completed and running.

Most companies have established specifications and standards for designers to follow in order to assure an adequate and safe operating facility. Frequently these specifications and standards are only concerned with the broad, general features, clearances and dimensions and not aimed at specifically minimizing maintenance costs. Several good articles have recently appeared stressing the need to modernize maintenance design standards based upon present maintenance practices. These articles stress using a minimum of built-in facilities, a maximum of portable and mobile equipment, and allowing adequate elevation and ground clearances to use this equipment efficiently. This modernization of design standards to allow use of mobile maintenance aids is a real contribution to low maintenance costs.

Present-day processes, alloys and equipment permit longer periods between shutdowns and, therefore, require more complete and intensified overhaul when a unit is shut down. A continuous operational period of less than one year is now generally considered poor. Not too many years ago, the same could be said of a 90-day running period. The design for maintenance must be kept up dated to this type of economic usage philosophy.

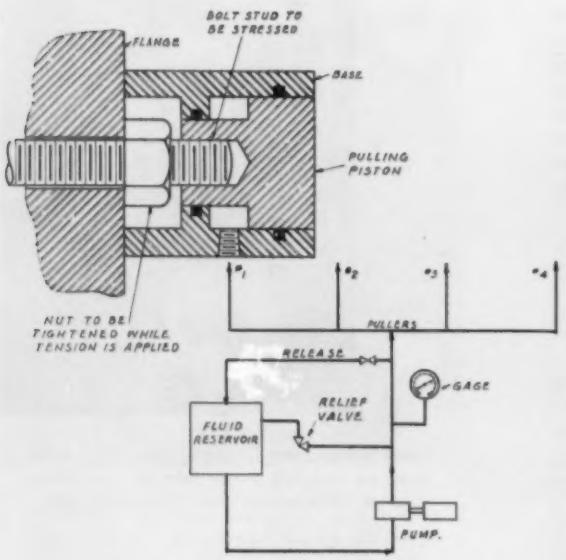

FIG. 1. Hydraulic tightening of bolts.....

Shows "hydraulic tightener" in place ready for insertion of pulling piston.

cost maintenance

Due to this constantly changing philosophy, maintenance people must continually search for means to eliminate items of excessive or too frequent maintenance, those things which slow down field maintenance and those things which can be more economically maintained through maximum usage of central or mobile facilities. With costs of labor and equipment constantly increasing, maintenance must search for the most economical usage of the company-invested dollar. If maintenance does not, through its own efforts, promote this thinking and study, they will find that undesirable changes will be forced upon them by "internal legislation." Maintenance must learn to compromise, promote and use new equipment, tooling, methods and practices in order to remain economically competitive within their own industry and especially with others who specialize in contracting for maintenance.

Here are a few items of design that have been found helpful in reducing maintenance costs and which are provided for in our company's specifications.

Large bolting

Trouble has been experienced with obtaining adequate bolt stress on flanges using bolts 2 in. in diam and over. In some cases this is due to the awkward location of the bolting and in others it may be due to other factors such as poor thread lubricant, poor selection of gasket materials, poor gasket surfaces, etc. But in all cases, the troubles were due to an inability to apply sufficient stress to the bolting. Efforts to control flange tightening through use of large torqued or torque control power wrenches proved impractical because of the difficulty of setting the wrenches to deliver constant torque and the varying relationship between applied torque and stress. The inaccessibility of many bolts made it necessary to use extensions and universal joints which waste power and further complicate calculations of true stress.

Use of electrical heating for tightening of bolting was studied, as it is used successfully in the tightening of many large turbine cases. This was discarded as impractical, due to the necessity of supplying hollow bolts for insertion of the electric heaters. At times this required larger diameter bolts, thus making this method uneconomical. The restriction on using electrical heaters in some process areas, the need for experienced electrical technicians to operate the heaters, the difficulty of inserting the heaters in certain tight locations, and the length of time required—say, to heat up and adequately tighten all bolts on several 48 in. diam flanges—were all considered. This, plus the estimated cost of equipment and labor to tighten several such flanges adequately and simultaneously, becomes prohibitive.

A further search led to consideration of hydraulically stressing the bolts to a specific, predetermined tension. Manufacturers of this type equipment were located and it was determined that small (relatively) hydraulic pulling heads could be manufactured to clear most physical obstructions and actually "stretch" the bolts to provide an even tension. This method was relatively quick, the results were easily reproducible and were not susceptible to varying friction factors, could be used in congested locations and only involved the normal bolt tightening crafts, so it was chosen as most practical. Hydraulic tightening has been successfully used for the past year with a significant reduction of bothersome leaking flanges.

Shows "hydraulic tightener" completely assembled for application of pull. Note micrometer mounted for "test" reading of actual stretch. This is related to hydraulic force applied.

Shows two of a set of four "hydraulic tighteners" applied ready for actual pressure application. Note that actual "stretch" is only measured on one bolt for random checking of results.

The method used in hydraulic tightening of flanges approaching 48 in. in diam involves the use of hydraulic pullers being applied simultaneously to four bolts. These are located at approximately 90° from each other. All are connected to a common hydraulic system. The hydraulic control unit used can be either electric or air driven and should be equipped with a discharge pressure gauge which reads pounds of stress for the connected pullers. Force is applied to all four units at the same time until the desired force is obtained. At this time the nuts are snugged down and the pullers moved to an adjacent position. This progresses until all bolts are tight and the first few retightened to check for over-relaxation. Proper tension is double checked by micrometer readings of the overall bolt elongation. These micrometer readings are only used for random checks of the hydraulic pressure readings.

This method required replacement of all flange bolting (as would the electrical heating method), as extra thread length was required for fastening the hydraulic pulling head. The additional length of bolt required approximates a length equal to the bolt diameter.

Bolt tightening problems occur most frequently on bolting 2" in diameter and larger. The adoption of hydraulic stressing has practically eliminated flange leaks which previously occurred because of insufficient bolt stress. As a result, a new design standard has evolved requiring the furnishing of this extra bolt length on all new equipment using bolts 2 in. in diam and above so as to allow use of hydraulic stressing when needed. This is a normal capital cost addition which insures better operating continuity as well as reduced maintenance costs (see Fig. 1 and pictures).

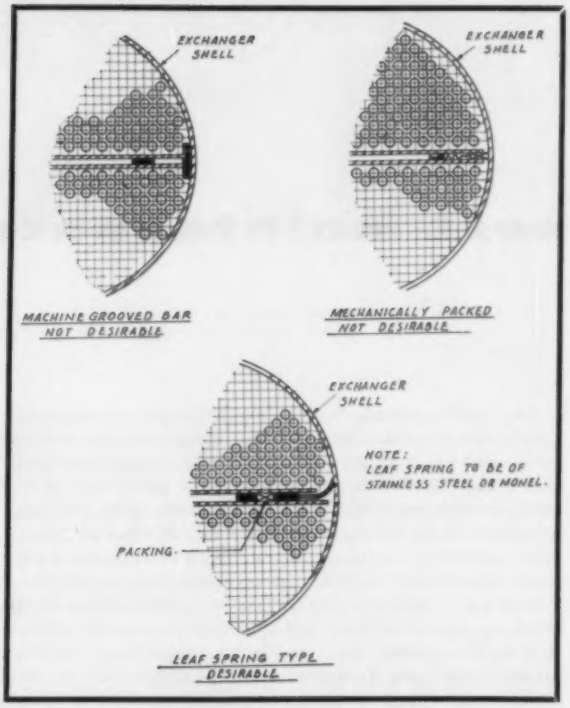

FIG. 2. Exchanger longitudinal baffle design.

High temperature

Trouble has been experienced in dismantling factory assembled high temperature equipment following service due to galling of bolts. It was determined that manufacturers' shops do not consistently use a suitable thread lubricant for long-time high temperature service. In these instances, it was impossible to disassemble the equipment, except by breaking or cutting the bolting loose. This caused an unnecessary cost in maintenance labor and lost down time plus the cost of a new set of bolting.

As a result of this, a new design standard now specifies that an acceptable high temperature thread lubricant must be used on equipment operating at elevated temperatures.

General suggestions

Trouble has been experienced during new unit turnarounds because non-standard bolting had been used on some of the heat exchange equipment. Maintenance was unaware of this problem and, consequently, considerable lost time was involved before makeshift tooling could be made and new tooling obtained so that the work could proceed. As a result of this, a design standard has been established requiring that the design engineers issue a detailed listing of all bolting types and sizes (including nuts) used on any project, along with the regular issue of job drawings. In addition, it is recommended that manufacturers use only standard nut sizes.

It is common maintenance practice to treat all large bolting and high temperature bolting with a penetrating oil and to clean rust from the exposed threads of such bolting to be removed during a shutdown. The oil application is used several times and the rust cleaned during the week preceding a scheduled turnaround. This saves shutdown time and manhours.

Heat exchangers

Trouble has been experienced with the removal of tube bundles having longitudinal baffles (two or more passes on the shell side). Due to fouling products of corrosion, poor fit or malfunction of this longitudinal baffle arrangement, removal of bundles has sometimes been very difficult and even impossible.

Under the most severe conditions, it has been necessary to cut either the bundle or shell apart to effect removal. Investigation revealed that in some cases redesign of heat

MEET THE AUTHOR

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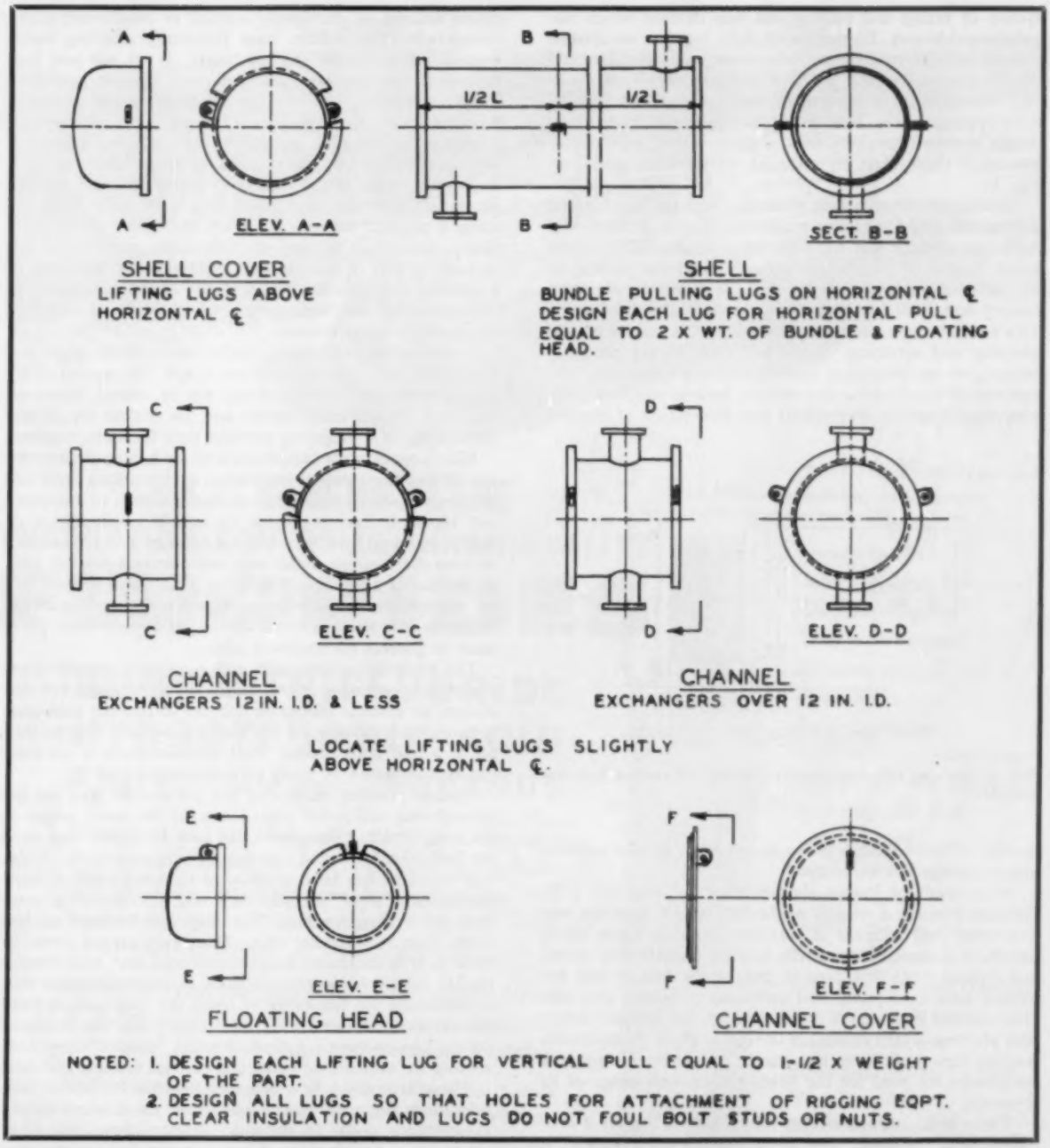

FIG. 3. Typical arrangement of lifting and pulling lugs on exchanger parts.

exchange trains, services and baffling could avoid this type of baffling completely at no additional capital or processing cost. In many instances, however, it is economically impractical to avoid two-pass shell side flow and, consequently, this type of baffling. For these instances, it became necessary to compromise on use of a combination of the least offensive and most efficient type arrangement. The compromise solution was a "leaf-spring" type of baffle (see Fig. 2) made of alloy steel which provides adequate surface contact yet resists "corrosion welding." Care must be exercised in the direction that the leaf spring faces to take advantage of the natural pressure drop. Care must also be taken in process design to assure that sufficient pressure drop is available to maintain the bundle in a static or "non-fluttering" position. Both of these conditions have been experienced.

As a result, a new design standard of the "leaf-spring" seal has been established. This results in easier bundle removal and, therefore, reduced maintenance costs.

Excessive rigging time has been experienced in removing heat exchanger components. Investigation revealed that this was primarily caused by a lack of lugs on the exchangers from which to rig. Combinations of miscellaneous chokers, slings, rods, etc., were used. This lack of adequate rigging caused uneven pulls which damaged exchanger nozzles, supports and insulation and, at times, damaged the flange faces so that it was difficult to keep units from leaking. A

system of lifting and pulling lugs was devised which has aided considerably. Proper use of these lugs has resulted in a more standardized rigging procedure, more standardized rigging equipment such as slings, clevices, etc., (not chokers) less damage to equipment and speedier handling of these appurtenances. This system of lugs has become a new design standard resulting in a slightly higher capital cost but more than offset by reduced maintenance cost (see Fig. 3).

Use of pull-through type exchanger bundles has become a design standard to reduce maintenance costs in removing, replacing, testing, and handling tube bundles. This allows easier testing of bundles in remote locations, pulling of bundles without removing the shell cover and a more satisfactory design for fastening of the floating tube sheet cover. This further augments savings possible with central bundle cleaning and servicing. Study and thought are presently being give to increasing central cleaning practices, new methods of handling bundles without built-in handling facilities, elimination of shell covers and elimination of channel

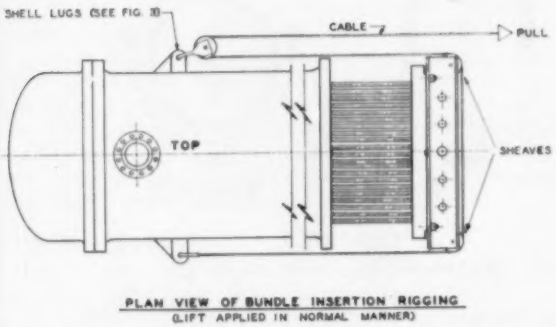

FIG. 4. Plan view of bundle insertion rigging (lift applied in normal manner).

covers. If these studies prove economical, further maintenance savings will be realized.

As a result of having built-in handling lugs and pull-through bundles, a simpler method of bundle insertion was borrowed and adopted as standard practice. Quite often insertion of bundles into shells requires considerably different rigging from that used in pulling the bundle and becomes time consuming and awkward to install and use. The method indicated in Fig. 4 (though not unique) solves this problem with a minimum of rigging effort. It minimizes rigging strung all "over the place," and in many instances eliminates the need for the floating head shell cover or its removal.

There is no such service as "clean service" when it concerns heat exchange. This term, though used widely, is only relative; i.e., the so-called "clean services" must be maintained in a cleaner condition and the smaller amounts of corrosion or dirtiness present are just as great a maintenance problem. For this reason, maintenance costs are reduced by *avoiding* small tubes (use 1 in. instead of ¾ in.), longer tubes (use 16 ft long instead of 20 or 24 ft) triangular pitch (square pitch lets you clean), U-tube bundles, etc. In unusual economic conditions, such things may not be avoidable. This may be the case when conditions require the use of more expensive alloys or the process concerns high temperature and pressure conditions, etc. Design standards should legislate in favor of long-time low maintenance costs in the above instances.

Utilities

Unnecessarily high maintenance costs have been experienced because of improperly located or insufficient utility connections. The utilities most frequently affecting maintenance costs are air and electricity, as all nut and bolt fastenings are presently handled with power operated impact wrenches. Efficient use of these power wrenches requires a very complete network of air lines and openings to insure that the time and effort saved in using the power wrench is not lost by the maintenance man having to hunt for an air outlet, install "Siamese" connections on existing air outlets, and having to string lengths of hose which become a physical hazard and inherently have high pressure drops. Too often air and electric utility connections are considered part of the over-all "utility station" program of a process unit and are, incidentally, located according to the location of the "wash-up and fire protection feature" of the ordinary utility station.

A close review of air and electric maintenance needs will reveal that they have no connection with the normal utility station needs and the two should not be related. However, the need for electrical outlets and air outlets are closely parallel and it is proper to consider their locations together.

Maintenance costs can be reduced by having a generous quantity of these outlets located on each working level and adjacent to where piping and equipment must be inspected and repaired. Locating them by simple consideration of cord length and hose length is not enough, as it is generally obvious that a single outlet must serve several possible jobs. In general, a good design standard is to place at least one air and electric outlet at every fractioning tower manhole elevation and to have them spaced no further than 25 ft apart in general maintenance areas.

The many air outlets, each with a separate shutoff valve, presents innumerable opportunities for air leakage. For this reason, air systems should be laid out so that the least used systems, such as those on fractionating towers, may be shut off as a unit until needed. Rust accumulations in air lines can be combatted by using galvanized piping.

Electric welding outlets of the permanent type on the normal unit are better placed around the outer edges of the unit. Welding equipment can then be placed and used for both shutdown and running maintenance work. A design standard has been established to make each of these connections "dual" so that they will accommodate more than one welding machine. The larger size breakers are less costly than two smaller ones. This saves capital costs. In order to trim shutdown maintenance costs and maintenance facility capital investment, a study is presently under way to determine the feasibility of using the intermediate sized process motor driver wiring for welding machine locations during non-operating periods. Special "plug-in" type connectors are available to make this practice feasible and safe.

These are only a few of an endless list of design considerations for maintenance which can result in minimized maintenance costs. In order to develop these and other maintenance saving ideas, it is imperative that maintenance people take an active part in the development of design standards. It is equally important that maintenance take an active part in new unit design, new unit layout and new unit construction. If this is done, your units will be more easily maintained and your maintenance costs reduced.

There is no comparable education for maintenance engineering and administrative personnel to that of being responsible for maintaining a unit in which you have a definite responsibility for the economic design and arrangement of its maintenance facilities. This, in itself, will contribute greatly to minimum maintenance cost, coupled with minimum maintenance facility investment. **Give the maintenance people an opportunity to contribute during the design phase and you will be rewarded by lower maintenance costs.** ★ ★ ★

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HARSHAW

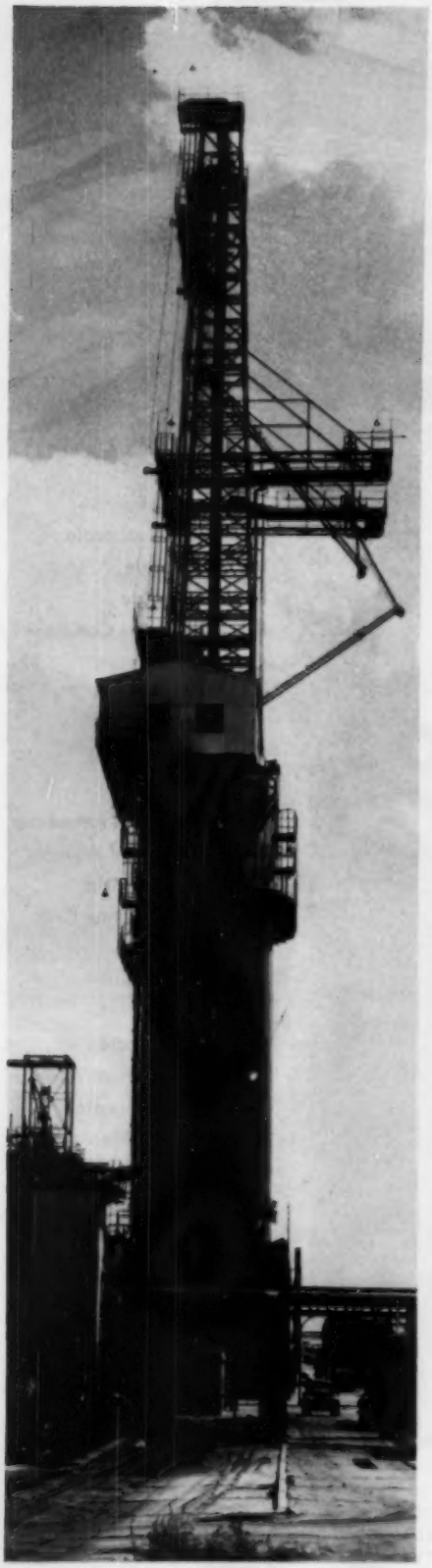


FIG. 1. 85-ft coke drum at Continental's delayed coking units stands 17 ft above grade, dumps into railroad cars.

Designed for Maintenance . . .

An inspection

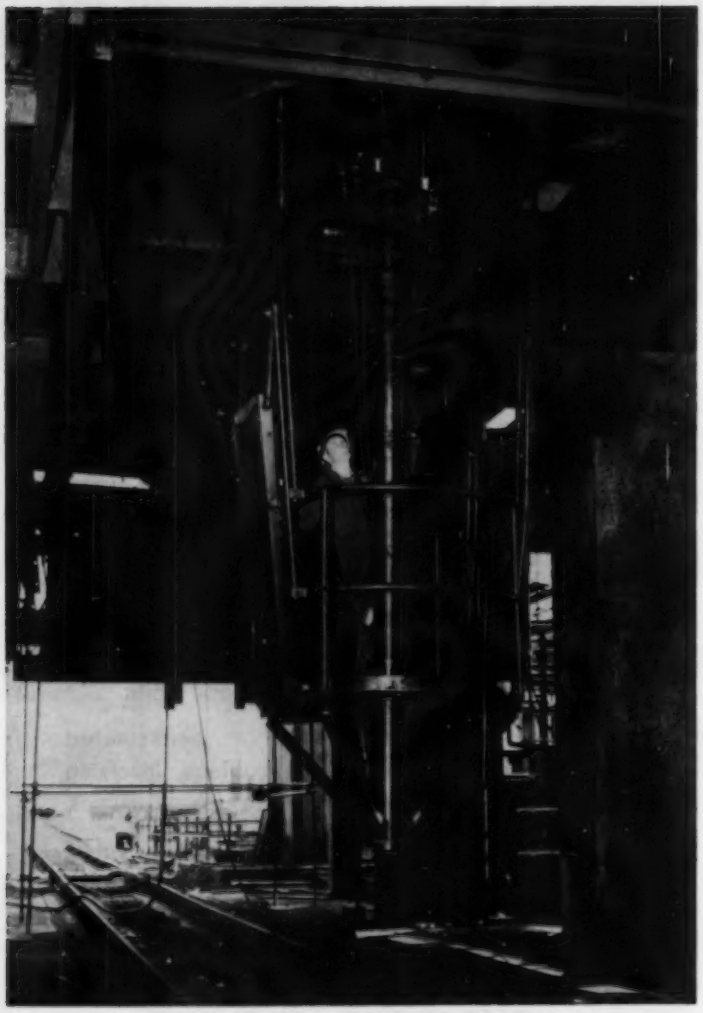


FIG. 2. Inspection platform . . . folded and ready for entry through 6 ft OD bottom manway.

platform elevator

E. A. SHELTON

E. A. Shelton is presently senior engineer of Continental's Technical Services Section, Engineering Department, and has been with Continental for the past twenty years. Previous experience includes five years with Universal Oil Products Company and twelve years with Shell Oil Company in various assignments, ranging from engineering design and development to field engineering supervisor on pipe line construction projects. Hobbies are gardening and music.

THOROUGH and methodical inspection programs, which have been in effect at Continental Oil Company's operating facilities for a number of years, have contributed largely to an excellent safety record.

When the delayed coker unit was installed at Ponca City in 1954, the two rather large coke drums presented a challenge for some sort of safe and practical method of internal inspection.

These drums are approximately 85 ft over-all length, 19 ft ID and mounted on a concrete structure providing 17 ft clearance from the bottom manway to grade (Fig. 1). Coke is removed from the vessels by hydraulic equipment utilizing high pressure water jets to break up the coke and clean the vessel walls. The coke drops through the 6-ft ID bottom manway into railroad cars spotted directly beneath the vessels.

Operating conditions on these drums are rather severe. Hot oil from the furnace is fed into one of the drums during a 24-hr cycle, after which the stream is switched to the second drum, while coke formed in the first is being removed.

The complete 16½-hr cycle of coke removal involves:

	Hours
1. Steaming and depressuring	1.5
2. Water cooling	3.0
3. Draining	2.0
4. Unheading, decoking, heading up, and steam testing	6.0
5. Heating	4.0
Total	16.5

The cleaned drum is preheated with vapors from the operating drum during the heating phase; thus the vessels are subjected to a temperature range from about 60 F to 900 F during each 24-hr cycle.

Base metal in the vessels is ASTM A-204 grade B, firebox quality normalized. The vessels are internally lined with a 7/64-in. thick, A-240, type 405, chromium, alloy, weld-applied lining.

Some minor amount of distortion over a period of time would normally be expected in vessels of this size operated under such severe conditions; however it was decided that a planned program of periodic inspection for the earliest possible detection of cracks, bulges, corrosion, or other defects would be a wise precaution.

Several ideas for interior inspection facilities were considered, such as a simple boatswain's chair and cable, temporary erection of suitable scaffolding, etc., none of which were considered as suitable from the viewpoints of **time, practicality, cost,** and **safety.**

Equipment furnished as part of the coke removal facilities appeared to lend itself very well to adaptation for use as an inspection platform elevator. A traveling platform was accordingly designed and constructed to utilize the existing facilities.

These facilities include a 6-in. double extra heavy pipe shaft which is lowered and raised on the absolute centerline of the vessels for their entire height during the cleanout operation. The boring tool rig also included an air-operated hoist mounted on the coke drum top platform, used for controlling the position of the drill by cable extension to the top of the drill rig.

The bottom manway inside diameter limited the size of any platform which could be drawn into the vessels; however, this was solved by utilizing two hinged gangplanks which, together with accessory handrails, can be folded into a nearly vertical position and locked until the platform has been drawn inside the manway (Fig. 2). A 15-ft long center mast of 6-in. double extra heavy pipe is provided at the center of the platform, the top end being equipped with a 5-in., 5000-lb "Unibolt" coupling to match the drill stem end connection (see Fig. 4).

The platform is placed on the ground below the vessel which is to be inspected, the drill stem is then lowered and connected to the mast, the folded platform is then raised to a position inside the vessel, and the gangplanks are lowered to their horizontal position

Continental Oil Company has made no attempt to patent this equipment, having in mind that similarly designed platforms will contribute to the safety of maintenance personnel and facilitate inspection for other companies using hydraulic decoking equipment or similar.

For this reason, Continental Oil Company will be happy to make detailed prints of the apparatus available to others on request at no cost other than for printing and mailing charges.

Continental Oil Company has asked that Petro/Chem Engineer coordinate all requests for these drawings. To get your complete set of design drawings, send $2.50 to cover the above costs to J. C. Webb, Editor, Petro/Chem Engineer, P. O. 1589, Dallas 21, Texas.

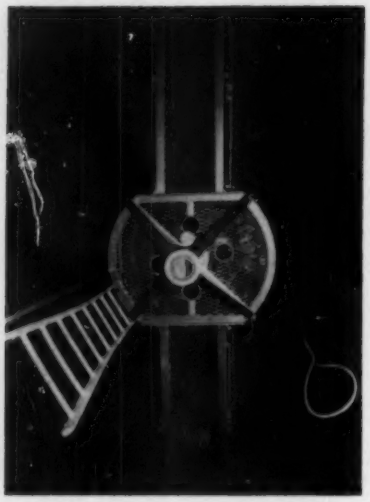


FIG. 3. Inspection platform seen from below after being drawn into position and lowering the inspection ramps.

(see Fig. 3 looking up inside the vessel).

The platform is now ready for use by the inspection crew consisting of two inspectors.

When in the horizontal position, the 180 deg opposed gangplanks extend to within less than 2 ft of the inside walls of the vessel so that the inspectors standing at each end are brought within "reading" range of the surface to be examined. The center bearing or hub of the platform consists of a pipe sleeve which permits rotating the entire assembly about the center axis. In actual operation, it was found that this works very well and that, while the platform remains in a fixed position without any undesirable spinning action, on the other hand it is easily rotated at will by the operators by the simple means of exerting pressure against the vessel wall with the hands.

Vertical travel of the platform is controlled by the hoist operator who operates the controls from the penthouse located at the top of the vessels. In order that this operation may proceed in a safe and orderly manner, a telephone is installed on the platform so that up or down movement is accomplished at the inspectors' request, and control of the distance traveled to within inches is easily obtained. Based on previous experience as to behavior of vessels operating in this type of environment, the need for a reliable vertical axis reference point was indicated.

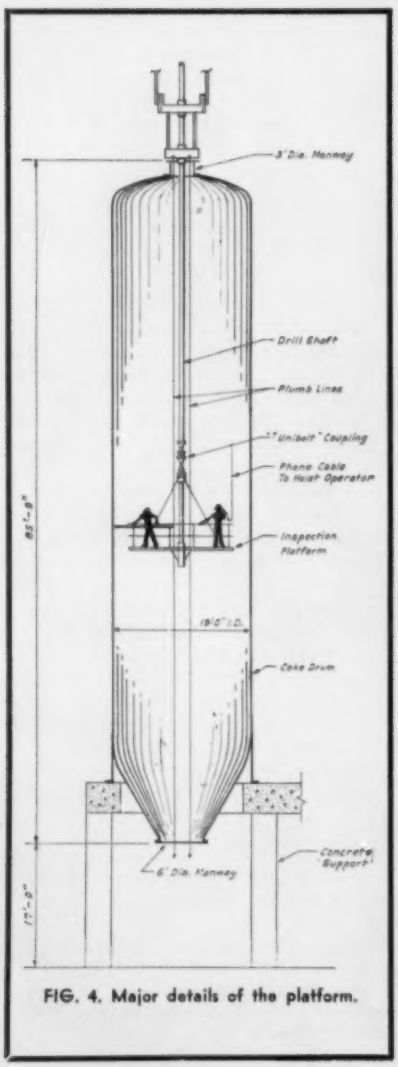


FIG. 4. Major details of the platform.

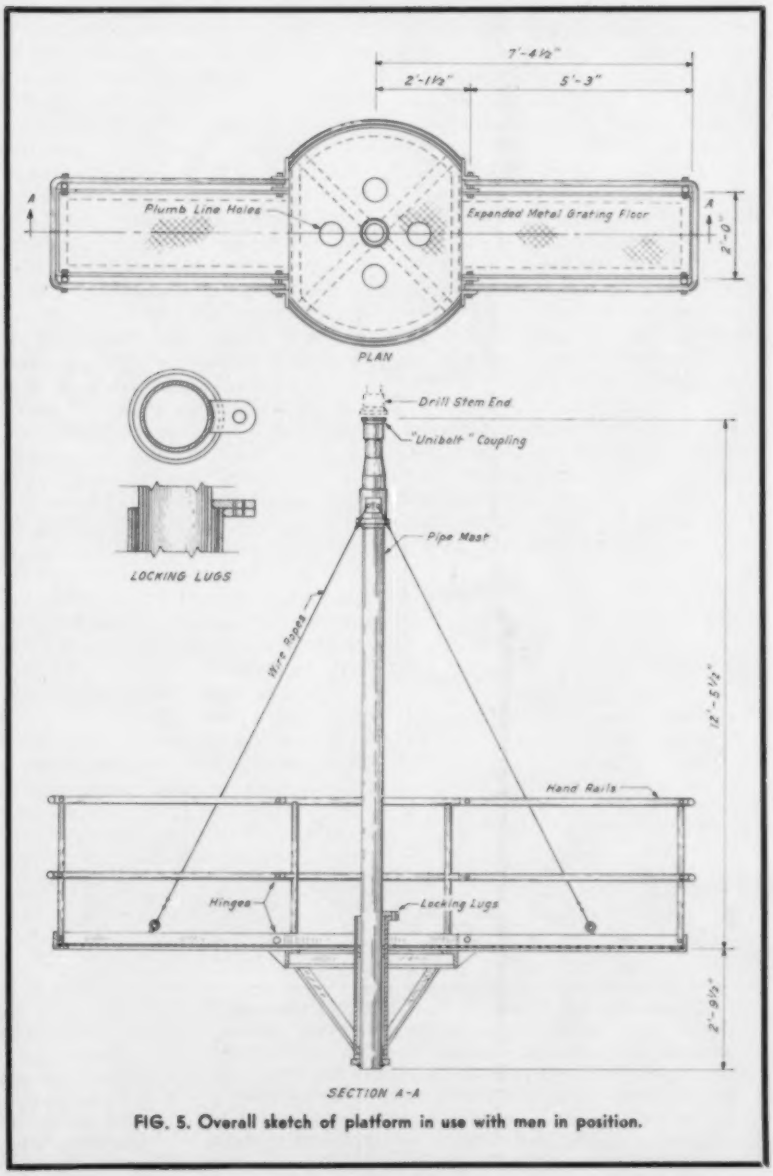
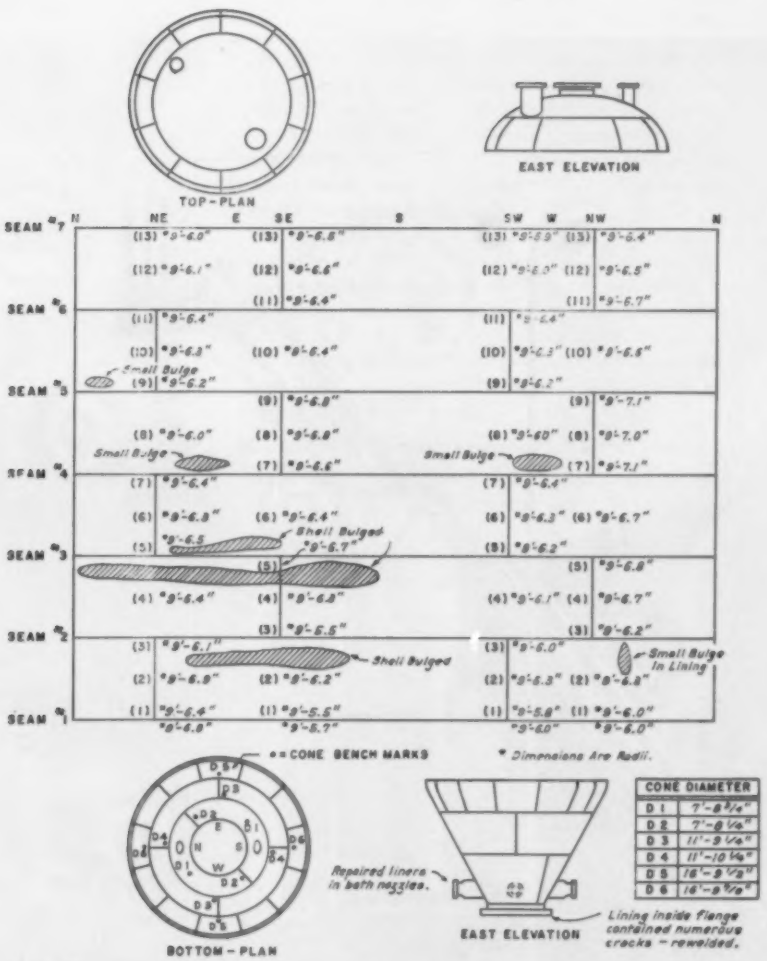


FIG. 5. Overall sketch of platform in use with men in position.

This would logically consist of a vertical plumb line dropped on absolute center of the vessel from which accurate radial readings of the side walls could be taken.

Since the centerline position is occupied by the 6-in. vertical pipe, it was decided to use two plumb lines made of 16 gage steel wire. A pattern was worked out placing these in radial positions one foot out from the vessel centerline.

The steel template from which the plumb lines are suspended is bolted to the top 3-ft diam manway flange. The template is drilled for four plumb line positions, each pair being 180 deg apart radially and aligned vertically with a duplicate drill pattern in the bottom manhole template.


DELAYED COKING UNIT
COKE CHAMBER WELD DIAGRAM
REFINERY NO. 1
PONCA CITY, OKLA.
NORTH CHAMBER
TOP - PLAN
EAST ELEVATION
N NE E SE S SW W NW N
SEAM #7
SEAM #6
SEAM #5
SEAM #4
SEAM #3
SEAM #2
SEAM #1
Small Bulge
Shell Bulged
Small Bulge In Lining
o = CONE BENCH MARKS
* Dimensions Are Radii.
CONE DIAMETER
D 1 7'-8 3/4"
D 2 7'-8 1/8"
D 3 11'-9 1/8"
D 4 11'-10 1/8"
D 5 16'-9 1/2"
D 6 16'-9 5/8"
Repaired linere in bath nozzles.
Lining inside flange contained numerous cracks - rewelded.
EAST ELEVATION
BOTTOM - PLAN
NOTES:
While I. D. measurements varied slightly from previous inspections, no serious bulging trends were indicated. Existing bulges in the shell had not changed seriously. The chamber was considered to be in satisfactory condition. Numerous small bulges were present in the lining, but this was not appreciably worse than last inspection. Two cracks in the lining in the bottom part of the shell and a large number in the cone were repaired by welding.
INSPECTED BY J.D. - F.W. DATE 7-58 SIGNED Frank Wolfe APPROVED

CONTINENTAL OIL COMPANY

FIG. 6. Inspector's record sheet with weld diagram showing variations in inside measurements and changes in lining condition.

Briefly, the inspection technique employed is as follows: The vertical plumb lines are installed in the first position approximately north-south and tightened at the bottom head template. Since the lines run through the platform 180 deg apart, the platform's radial position is locked in place with the locking lug mechanism; and rotation is thus prevented. North-south readings are taken at all circumferential and vertical seams throughout the vessel's height. During the first trip, the inspectors are concerned only with vessel diameter readings to detect and measure internal or external bulging. This operation employs the use of an aluminum gage rod equipped with carpenter level vials as shown in Fig. 6 and with which radial readings are taken to four vertical reference lines, identified inside the vessel walls by stainless steel markers welded to the vessel walls. On completion of the north-south readings, the plumb lines are rotated 90 deg to coincide with the east-west reference points; and the measuring procedure is repeated. All readings are logged (see Fig. 7) and compared with those from the previous inspections.

On completion of this work, the plumb lines are withdrawn; and the locking mechanism is disengaged so that the platform is now free to rotate.

Inspection runs are now made for careful examination of the entire surface. This technique employs visual examination with the aid of flashlights, magnifying glasses, and other small tools, such as wire brushes, scrapers, etc.

The total weight of the platform is approximately 1600 lb. Since transportation and handling of the equipment between storage yard and plant site are by crane, the weight has not been a handicap; however, it could undoubtedly be reduced by some modification of design and by using aluminum for at least a portion of the component parts without seriously impairing strength. Since, however, the platform is subjected to rather severe usage, such as carrying equipment for welding, inspection, and repair crews, it was decided to use carbon steel throughout.

There is some noticeable deflection of the drill shaft while in its lowest position when unbalanced loads are applied, but this is not serious enough to foul the plumb lines and is of no consequence when the platform is operated with reasonably balanced loading of the gangplank ends.

Summarizing briefly, the apparatus adequately serves its purpose of providing safe and efficient means for internal inspection and repairs to these vessels. ★ ★ ★

This mark tells you a product is made of modern, dependable Steel.

Now you can cut pressure vessel weight

The use of 299 tons of USS "T-1" Steel in these two Hortonspheres saved 216 tons of carbon steel and 42% in shipping costs. Designed and erected by Chicago Bridge & Iron Company for storing propane gas in Venezuela. These tanks were designed to the old code limits, but under the new code limits they could have been made up to 9.5% lighter.

Revisions in case 1204-4 of the ASME Code for boilers and pressure vessels increase maximum allowable stress value to 28,750 psi for "T-1" Steel. This permits further reductions in weight up to 9.5%.

even more with USS "T-1" Steel

The new figure of 28,750 psi represents an increase of 9.5% over the previous maximum allowable stress value of 26,250 psi which applied to USS "T-1" Constructional Alloy Steel used in pressure vessels. This means that USS "T-1" Steel can be used to reduce weight even more than it did before in stationary vessels or truck tanks.

The steel frequently used in welded, unfired pressure vessels is ASTM A-285-Grade C. This steel can be used with a maximum allowable design stress of 13,750 psi. From this, you can see that the allowable stress for "T-1" Steel is 2.1 times greater. To put it another way, plates of "T-1" Steel in a pressure vessel need be only half the thickness of A-285-C plates to withstand the same stress.

15% overall savings possible with "T-1" Steel

USS "T-1" Steel permits a 50% reduction in the amount of steel used in the vessel; this results in large savings in the cost of structural supports and foundations, welding, freight, handling costs and the elimination of stress relieving costs.

In a recent design, pressure vessels designed of both A-285-C steel and "T-1" revealed the following cost analysis:

	Use of "T-1"
Weight of steel	saved 50%
Cost of steel	only 20% more
Fabrication cost	saved 40%
Freight	saved 50%
Amount welding wire	saved 60%
Total savings	15% cheaper overall

These savings, plus USS "T-1" Steel's unique combination of toughness at low temperatures, high strength at elevated temperatures, and weldability, offer the pressure vessel designer the *only* material of this high strength level possessing *all* the qualities so important in the pressure vessel field.

For more information, write United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

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Stop "hot process" foundation settlement

BRAMLETTE McCLELLAND

Four case histories show you what can happen. Then, by combining theory and field experience, design concepts are offered that will help you AVOID or CORRECT similar problems.

A BRICK KILN, 200 by 100 ft in base dimensions and resting on 9 ft of brick rubble over stiff fissured clay, was worked every day for 30 years. It was then demolished. Eleven years later, extreme distress was encountered with another foundation erected on the same site. A thorough investigation of the site was made and here are the results.

A test pit revealed that the soil temperature gradually increased from 70 C at a depth of 16 ft to 390 C at 35 ft. Work in the pit was stopped because of the intense heat. Borings were used to continue the tests. These borings showed soil desiccation to 65 ft, where the soil was underlain by bedrock.

It is a familiar fact that some soils,

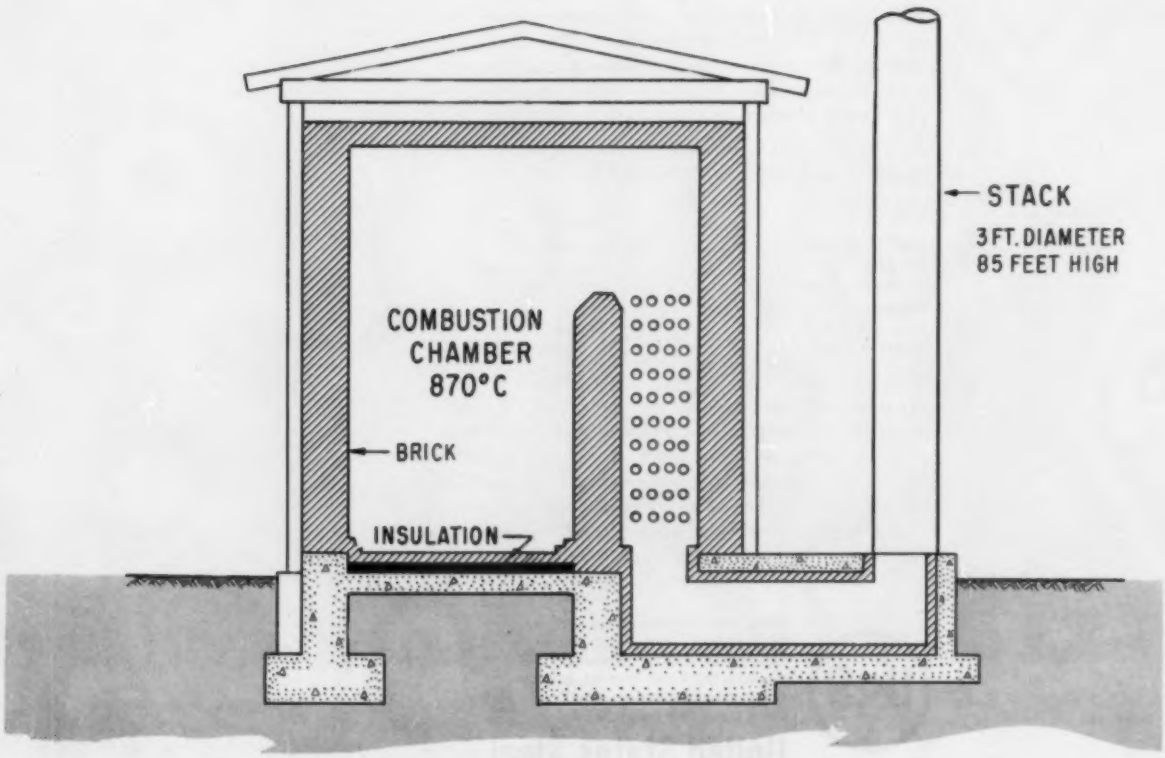

FIG. 1. Case I, refinery pipe still — vertical cross section.

subjected to heat, will dry out and shrink. Not so well-known, however, are:

- Depths to which heat penetrates
- Extremes to which the desiccation can proceed
- Period of time over which the process sometimes extends

The case with the kiln is extreme because of the high temperature and the long duration of exposure to the heat source. To a lesser but still serious degree, settlements due to similar causes have occurred in many areas including the Gulf Coastal Plains of the United States, where soils are highly susceptible to shrinkage.

Most heavy industries utilize one or more types of structures which operate at relatively high temperatures. These "hot process" structures include such units as steam boilers, refinery stills, fired heaters, kilns, etc. In a number of instances, foundations for these particular units have been found to experience settlements far in excess of those normally resulting from the compressibility of the supporting soils. Investigation has shown that these settlements can be attributed to the desiccation and shrinkage of the supporting soils as a result of heat transmitted through the foundations.

MEET THE AUTHOR

BRAMLETTE McCLELLAND, president of McClelland Engineers, Houston-based soil and foundation consultants, is a registered professional engineer in Texas and Louisiana. He holds a BS in civil engineering from the University of Arkansas and a MS in civil engineering, with major in soil and foundation engineering, from Purdue University. He was a research engineer for Purdue and a design engineer in charge of soil and foundation investigation for the San Jacinto Dam for the City of Houston before becoming a partner in the foundation engineering firm of Greer & McClelland, Houston, in 1946. He assumed his present position in 1955.

Here are four case histories for which extensive field and laboratory data have been developed.

Case 1:

Refinery pipe still

A pipe still was constructed in 1925 at a refinery on the Houston Ship Channel. Fig. 1 is a sectional view of the still, showing its attached stack and relatively shallow spread footings. The combustion chamber operated at about 870 C and was separated from the underlying soil surface by layers of brick, concrete, and insulating material. Rate of settlement observations for this unit are not available, but in 1952, 27 years after the unit was built, differential settlement between adjacent corners was as much as 1.3 ft and settlement was still progressing.

The site was investigated by three borings in 1952, No. 1 at some distance from the still, No. 2 alongside it, and No. 3 slanting beneath it from a point nearby. The borings were made dry in order that temperature measurements of each core and ground water observations in each boring could be made with accuracy. To obtain a clear picture of the heat flow conditions and the resulting soil temperature distribution, the flow-net shown in Fig. 2 was constructed from the observations of temperature in borings No. 2 and 3. A two-dimensional system was assumed for this graphical interpretation. The flow-net indicates that the combustion chamber temperature of 870 C was reduced by insulation in the floor of the still to a maximum temperature at the soil surface of approximately 175 C. In spite of this reduction, temperatures exceeded the boiling point of water to a depth of about 12 ft and were 50 C or more to about 35-ft depth.

A typical soil profile and profiles of temperature and moisture content variations beneath and away from the heater are shown on Fig. 3. The soils are typically preconsolidated clays of the Beaumont clay, a formation of Pleistocene age. Only moderate reduction in moisture content was observed in the boring which slanted beneath the still, but this was noticeable over an appreciable depth range. A higher degree of desiccation undoubtedly existed closer to the base of the still where the temperature approached 175 C. No measurable desiccation was found at boring No. 2, 10 ft away from the still. Temperatures there ranged from 34 to 52 C, indicating that temperatures in excess of 50 C were required at this site to produce appreciable desiccation and shrinkage.

Case 2:

Power plant boilers

Eight boilers, each approximately 25 by 25 ft in plan, occupy the low-pressure boiler room at one of the earliest steam electric stations built in Houston. Beneath the firing aisle, which runs through the center of the room, is a circulating water tunnel. Two of the boilers are on one side of the aisle and six are on the opposite side. Boilers have occupied this room since 1900, originally using fuel oil. They were converted to the use of gas as fuel in 1939 and, after ten more years of continuous service, were placed on intermittent operation in 1949.

A diagrammatic cross section of one of the boilers is shown on Fig. 4. As in this case, most of the boilers were built with their front footings (near the firing aisle) at about 5-ft depth, and their rear footings at about 12-ft depth. Since the boilers were converted to gas fuel, temperature at the bottom of the firebox is about 1040 C. Soil beneath the boiler room floor is separated from the firebox by a course of brick, approximately 6 in. of concrete and several inches of sand.

By 1944, serious settlement of the boilers was evident, and level observations were initiated on a series of bench marks established on the vertical I-beams that frame the boilers. Time vs settlement records of Boiler No. 2, which settled the most, are shown in Fig. 5 for both front and rear footings. Greater settlement of the front footing is generally true of all the boilers, apparently due to overlapping heat effects from adjacent boilers and to the comparatively shallow elevation of the front footings. Maximum settlement between 1944 and 1949 was 0.26 ft; total settlement between 1939 and 1949 was probably more than twice that amount.

Soil conditions existing in the boiler room area near Boiler No. 2 were explored in 1948 by means of undisturbed sample borings and test pits. In each of these pits the soil was found to be extremely dry and powdery, and the surface of the underlying soil had pulled away from the bottom of the concrete floor by as much as 6 in. (Fig. 6). In one test pit, the concrete column rising from a front footing of Boiler No. 1 was observed to be cracked horizontally in two places, indicating that soil shrinkage acting on the spread portion of the footing had pulled it downward (Fig. 7).

To determine the extent of the heat effects in the soils below the boiler room floor, the water contents of samples obtained from borings inside the boiler room were determined and compared with those just outside the structure. Results of some of these tests, together with a generalized soils profile, are shown in Fig. 8 and clearly indicate the extent of desiccation. In one boring inside the boiler room, selected for this profile, drying was very

marked down to Elev. + 30, a depth of 20 ft. In another boring, not illustrated here, desiccation was found to Elev. + 34, a depth of 16 ft.

As a result of the investigation of these foundations and because settlement was still increasing, the front footings which had settled the most were removed and those boilers were underpinned with new footings 11 ft deeper. Air space with forced-draft ventilation for heat removal was added at floor level in two of the units. As had been planned for some time, all boilers of this group were placed on standby basis in 1949 as soon as new units at the plant were installed. Since then, as indicated by Fig. 5, settlements have stopped and footings have risen slightly in some cases.

Case 3:

Refinery boilers

The subject of the next case history is a group of five boilers built in another Gulf Coast refinery between August 1946 and October 1948. Fig. 9 is a generalized cross section showing the type of foundation used and its position relative to the combustion chamber. The gas-fired combustion chamber, which operates at approximately 950 C, was separated from the soil surface by a brick floor, a dead air space, and 2 or 3 ft of sand fill. No dead air space was provided beneath the mud drum, and heat on that side of the boiler passed only through sand fill and a concrete mat before reaching the underlying soils.

Settlement of the oldest boiler in this group, designated as No. 11, was noticed in 1949, approximately three years after its construction. Elevation observations at a large number of points on the foundation of this and all other boilers in the group have been made at regular intervals since that time. The observations at two of the points on Boiler No. 11 are plotted in Fig. 10 and indicate that a maximum settlement of 0.36 ft or about 4 in. was reached in 1952.

In each of four borings in this area, made in January 1952, soil temperatures and moisture contents were measured. Other observations indicated that the ground water level had been depressed to a depth of 12 ft near the edge of Boiler No. 11, compared to a depth of 6 ft outside the boiler area. Results of the temperature and moisture content observations in the boring adjacent to Boiler No. 11 and in a boring outside of the boiler area are shown in Fig. 11, which also describes the foundation soils. Similar data were not obtained directly beneath the boiler. However, it can be certain that the trend toward higher temperatures prevailed toward the centers of the boilers in a manner similar to that indicated by the flow-net for Case 1, Fig. 2.

Continued settlement of the boilers

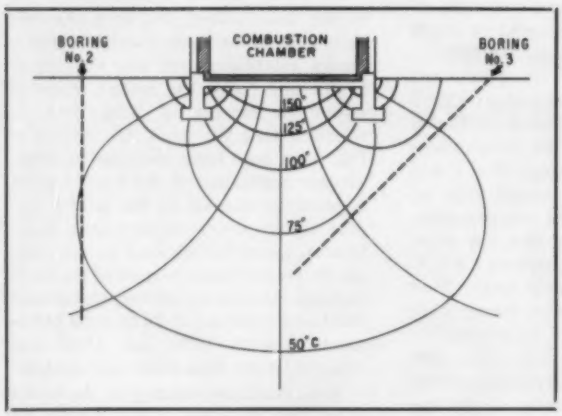

FIG. 2. Case 1, refinery pipe still — heat flow net.

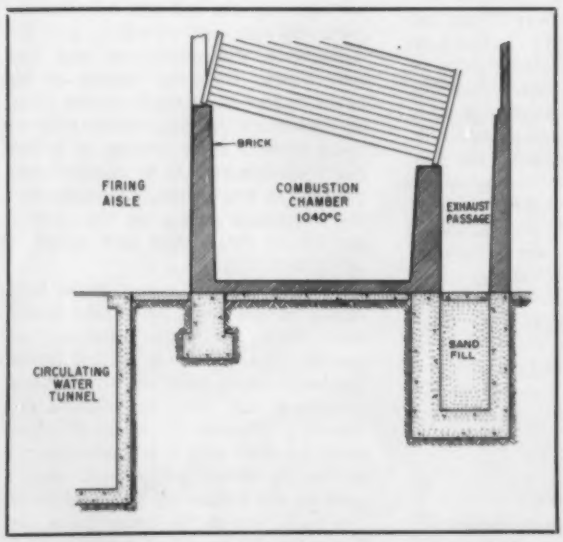

FIG. 4. Case 2, power plant boilers — vertical cross section.

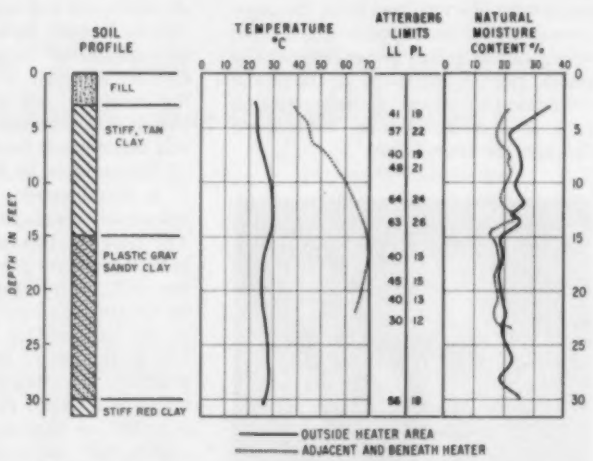

FIG. 3. Case 1, refinery pipe still — soil, temperature and moisture content profiles.

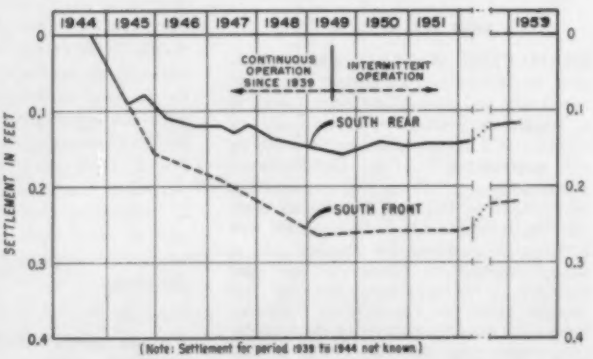

FIG. 5. Case 2, power plant boilers — typical settlement curves, Boiler No. 2.

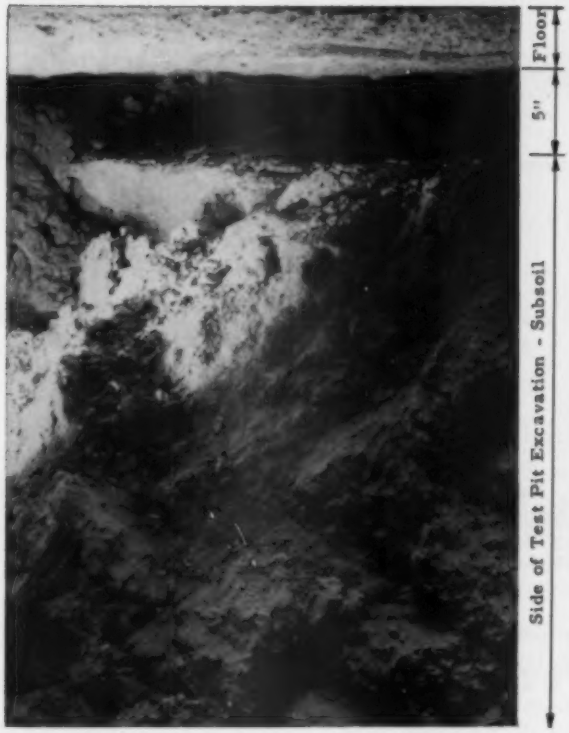

FIG. 6. Case 2, power plant boilers — settlement of soil surface beneath firing aisle floor.

FIG. 7. Case 2, power plant boilers — view of tension crack in foundation column, Boiler 2.

was anticipated as a result of the soils study. Consequently, an insulated baffle was placed beneath the mud drum in each of the boilers, forming an air space beneath it similar to that already existing beneath the firebox. A blower system was then installed to force circulation of air in the spaces beneath the baffle and the firebox floor. Thermocouples attached to steel plates placed a few inches beneath the surface of the sand fill indicated temperatures there of approximately 300 C before these modifications and only 55 C afterward.

Effectiveness of these measures, designed by the engineering staff of the refinery, can be judged from the settlement curves in Fig. 10. A small and slow upward movement of the foundations is now occurring. This is another indication that soil temperatures in the order of 50 C will not cause desiccation and settlement for the soil and ground water conditions found at this location.

Case 4:

Aluminum reduction plant

A similar study was made for an aluminum reduction plant, another type of hot process structure, at a site having soil and hydrologic conditions different from the cases previously described. At this plant, heat produced in the electrolytic reduction of aluminum oxide caused soil temperatures slightly in excess of 100 C at the base of the foundations. These foundations, called "pot slabs," are at a shallow depth and rest on 26 ft of residual silty clay, underlain by cavernous limestone. The investigation in this case, in contrast to the others, was made because trouble had *not* developed. The purpose of the study was to determine, if possible, the reasons why the known high temperatures at this plant had not caused significant settlement.

A dry boring through one of the slabs, made shortly after removal of the aluminum pot, revealed soil temperature variations similar to those previously encountered, as indicated in Fig. 12. However, the zone of desiccation, as shown by the moisture content plot in Fig. 12, was found to be limited to the depth within which soil temperatures exceeded 87 C. This is in contrast to results of studies in the Gulf Coast area where temperatures down to 50 C have been found to cause desiccation. The cause of this relatively shallow zone of desiccation was concluded to be the comparatively high permeability of the soil, accompanied by a shallow ground water level. Under these conditions, the balance between water removed by evaporation and water resupplied from ground water sources is established at a higher temperature than would otherwise be possible. The existence of high soil permeability was established by observations of fluctuations of the ground water level over a period of several days during which there was occasional rainfall.

Theoretical temperature distribution

Supplementing information from direct field observations, some assistance in understanding the problem of heat effects can be found in theoretical treatments of the subject. Mathematical analyses of heat flow in soils have been made by various investigators, including Ruckli[2] and Ward[3]. For steady-state flow from a long rectangular heat source located at the ground surface, assuming the surface temperature constant outside the heat source, the equation for temperature variation beneath the center is:

$$\tan\left[\frac{\pi}{2}\,\frac{(T-T_1)}{T_o-T_1}\right]=\frac{B}{h}$$

where:

- B = width of the heat source
- h = depth below center of heat source
- T = temperature at depth h
- T_o = source temperature
- T_1 = temperature of ground surface outside the heat source.

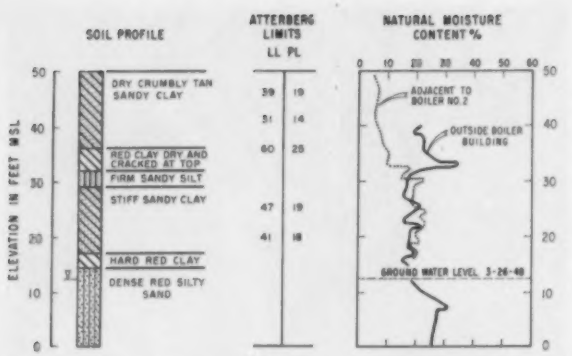

FIG. 8. Case 2, power plant boilers — soil and moisture content profiles.

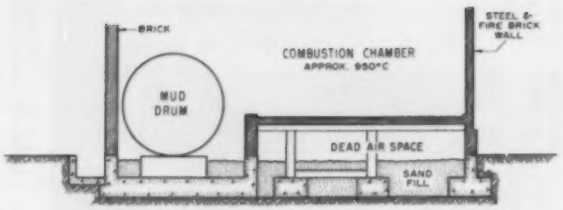

FIG. 9. Case 3, refinery boilers — vertical cross section.

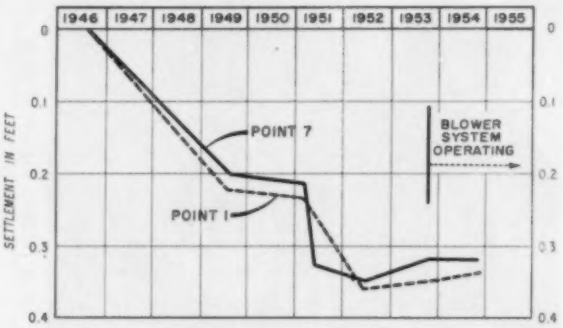

FIG. 10. Case 3, refinery boilers — typical settlement curves. Boiler No. 11.

This equation indicates that the depth to any given temperature will vary with the source temperature and the width of the heat source, once steady-state heat flow has been established. The stated relationship holds for a two-dimensional flow system. For three-dimensional flow, the relationship is considerably more complex. Equations by Ruckli[4] determined for a mathematically similar problem permit the computation of depths of various temperatures beneath the center of a circular heat source. For both the two and three-dimensional cases, the stated boundary conditions require that all isothermals have the form of circular arcs passing through the edges of the heat source. The position of the isothermal corresponding to any desired temperature can therefore be determined if the heat source and ground surface temperatures are known. Fig. 13 shows relative positions of various isothermals corresponding to 10% increments of the temperature difference causing flow, both for two and three-dimensional systems. The two-dimensional pattern applies specifically to a heat source having a long rectangular shape, and three-dimensional pattern is for a circular-shaped heated area. By interpolation between the curves of Fig. 13 the depth to any desired temperature can be estimated for a particular problem.

Theoretical equations expressing the transient state of heat flow and time required for development of steady-state conditions have not yet been derived. The complexities and unknown soil constants involved in the theoretical treatment of the time influence suggest that an empirical approach might be more fruitful at the present. Available published data are not sufficiently detailed to permit any conclusions relative to this factor, other than to indicate that settlements may extend over a considerable period, as observed in Cases 1, 2 and 3.

Prediction of desiccation settlements

Useful in predicting the behavior of foundations for heat-releasing units is information on the shrinkage characteristics of the foundation soils. In the studies of existing hot process units previously described, special shrinkage tests on undisturbed samples were performed to provide such information. In this test a 3-in. diam cylindrical specimen 3 in. in height was air-dried from natural moisture content at 30 C and then was oven-dried at 105 C. The measured change in height expressed as a percent of the initial height is termed the undisturbed shrinkage. Examples of shrinkage curves from tests of this type are shown in Fig. 14 for typical Pleistocene clays of the Gulf Coast, each having different Atterberg limits. The portions of shrinkage occurring during air-drying at 30 C and during oven-drying at 105 C are also indicated on the shrinkage curves.

Observed settlements of hot process structures in the Gulf Coast have been checked with reasonable accuracy by employing results of such shrinkage tests and estimating the depth of partial and complete desiccation from the curves presented in Fig. 13. In estimating the extent of desiccation, the approximate assumption was made that all soil raised to a temperature in excess of 100 C would be completely desiccated. The zone of soil enclosed between the 100 and 50 C isothermals was assumed to experience an ultimate shrinkage corresponding to the air-dried undisturbed shrinkage.

Computed settlements for the observed temperature conditions are compared with measured settlements for three of the cases previously described in the following table:

	Settlement, ft	
	Observed Maximum	Computed Maximum
Case 1	1.3	1.0
Case 2		
(rear footing)	0.14*	0.29
(front footing)	0.26*	0.43
Case 3	0.36	0.40

*Observed settlements for Case 2 are for period of 1944-1949; it is estimated that total settlements for this case are at least twice these amounts, since the period of observation is only one-half the total duration of gas firing of these boilers.

Observed settlements in Case 1 may be somewhat more than the computed settlement due to the ultimate collapse of the soil structure and the filling of vertical shrinkage cracks. This phenomenon was observed in test pits in Case 2.

Prevention of desiccation settlement

Studies included in this paper suggest a number of foundation treatment which will inhibit settlement of existing structures and prevent desiccation settlement of future installations. These can be grouped into three main categories:

1. Prevent temperature rise above 50 C in foundation soils.

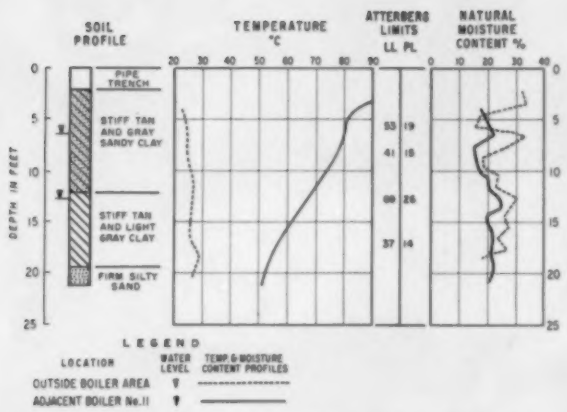

FIG. 11. Case 3, refinery boilers — soil, temperature and moisture content profiles.

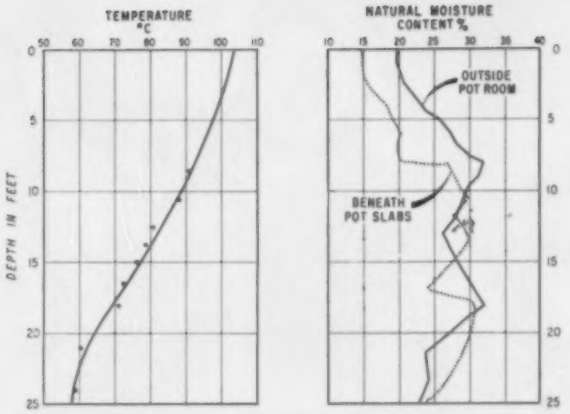

FIG. 12. Case 4, aluminum reduction plant — temperature and moisture content profiles.

2. Re-supply soil water in order to maintain moisture equilibrium at temperatures higher than 50 C.
3. Support structure on soils below zone of desiccation.

These measures can be applied singly or in combination.

A rise in soil temperature above 50 C theoretically can be prevented by providing a sufficient thickness of insulation between the soil and heat source. In all cases similar to the case histories described, however, the required thickness will be excessive. Ward and Sewell[3] have shown that the required thickness of insulating brick for a 60-ft wide rectangle heated to only 278 C would be 13 ft. Even if insulation as good as cork were used, 4.5 ft would be required to keep soil temperatures below 50 C. Thus, to keep soil temperatures below 50 C, some means for removal of heat passing through the floor of the combustion chamber or other heat element must be employed. The most obvious means for accomplishing this is by circulating air, either natural or forced draft. Forced draft was applied in Case 3 and to date has proved quite successful in reducing settlement.

The establishment of a soil moisture equilibrium at temperatures higher than 50 C can be carried out in special cases, both for existing and future installations. In existing structures the installation of an irrigation system around the periphery of a unit should effectively arrest future foundation movements, if soils are sufficiently pervious or include seams of pervious soils. Design and efficiency of such a system will therefore depend on the general soil stratigraphy and properties existing at a given site. In the design of future installations a moisture balance can be obtained by installing underdrains in a sand blanket placed between the undisturbed soil and the foundation slabs. Water supplied to the soils through the underdrains could maintain equilibrium at higher temperatures and reduce desiccation of the supporting soils. To date neither of these methods, the irrigation well system or the underdrain method, has been used.

Another positive approach to the foundation design has been to support the structure on foundations extending through the expected zone of desiccation. This method is most satisfactory for structures with a potential zone of desiccation that is limited in some way, either because the heated area is small and the temperature of the heat source is low, or because the thickness of soil subject to shrinkage is small.

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2. Ruckli, R. F. X. "Heat Flow Toward the Floor of Cold Stores and Calculation of the Insulation or Heating System to Prevent Frost Penetration in the Ground," *Proc.* Second Int. Conf. Soil Mech., Vol. I, 1948.

3. Ward. W. H., and Sewell, E. C. "Protection of the Ground from Thermal Effects of Industrial Plant," *Geotechnique*, Vol. II, No. 1, June 1950.

4. Ruckli, R. F. X. "Two and Three-Dimensional Ground-Water Flow Toward the Ice-Lenses Formed in Freezing Ground," *Proc.* Second Int. Conf. Soil Mech., Vol. II, 1948.

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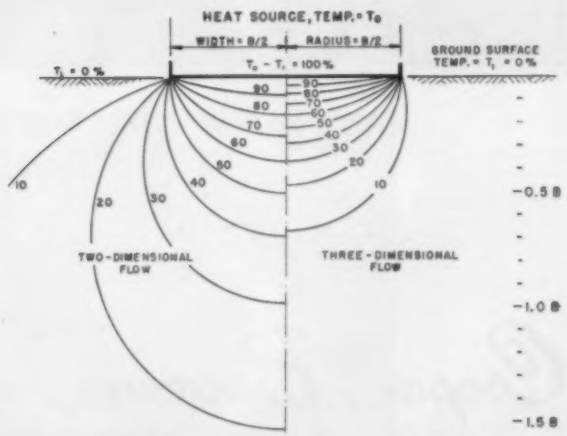


FIG. 13. Soil temperature distribution for two and three-dimensional heat flow.

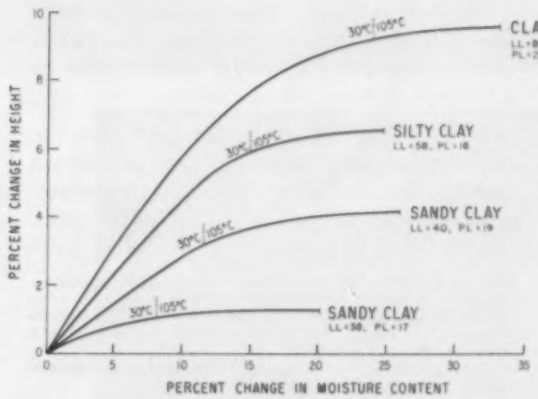
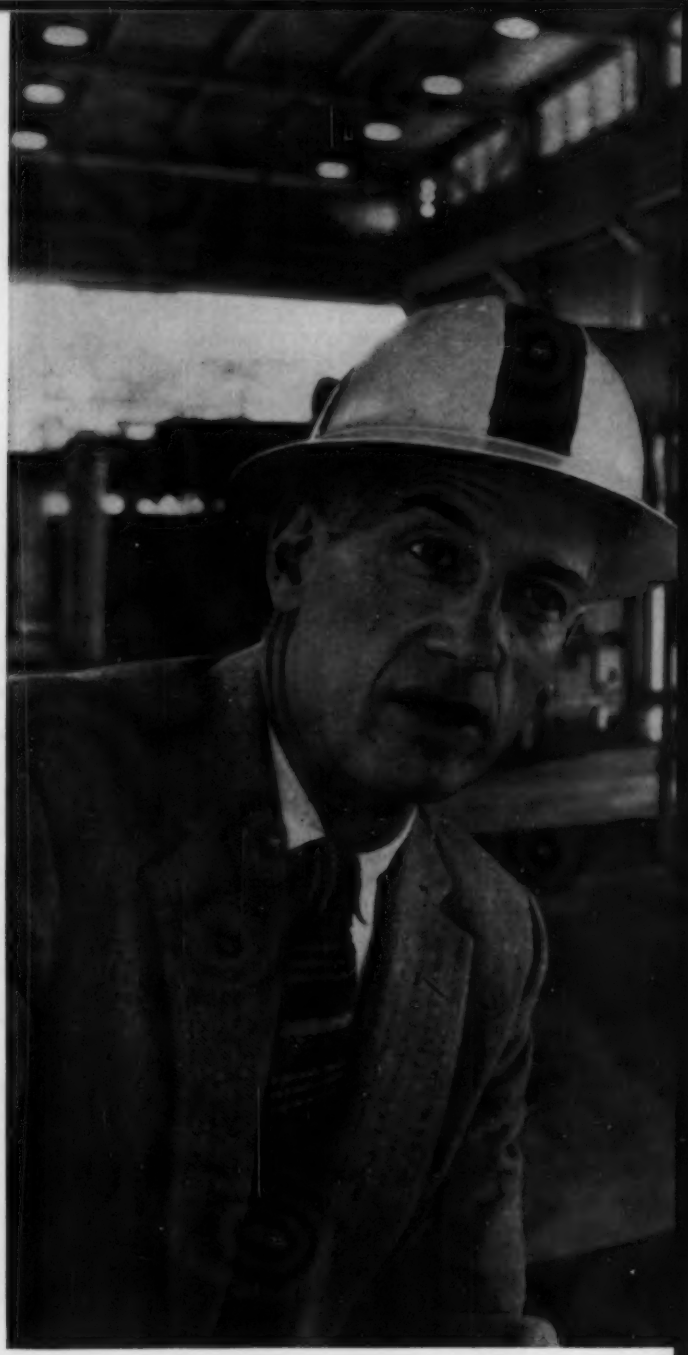


FIG. 14. Examples of shrinkage curves for stiff Pleistocene clays, Texas Gulf Coast.

Report from Tidewater...

How Cooper-Bessemer hydrogen boosters supply 800 psi 'round-the-clock



At Tidewater Oil Company's refinery south of Wilmington, Delaware, two Cooper-Bessemer FM-2 compressors play a vital part in the hydrogen treatment process by which the refinery upgrades a number of products and intermediate fractions. These hydrogen boosters operate 24 hours per day, boosting 690 cfm of hydrogen at 470 psi to a discharge of 800 psi. This hydrogen is delivered directly to the desulfurizers.

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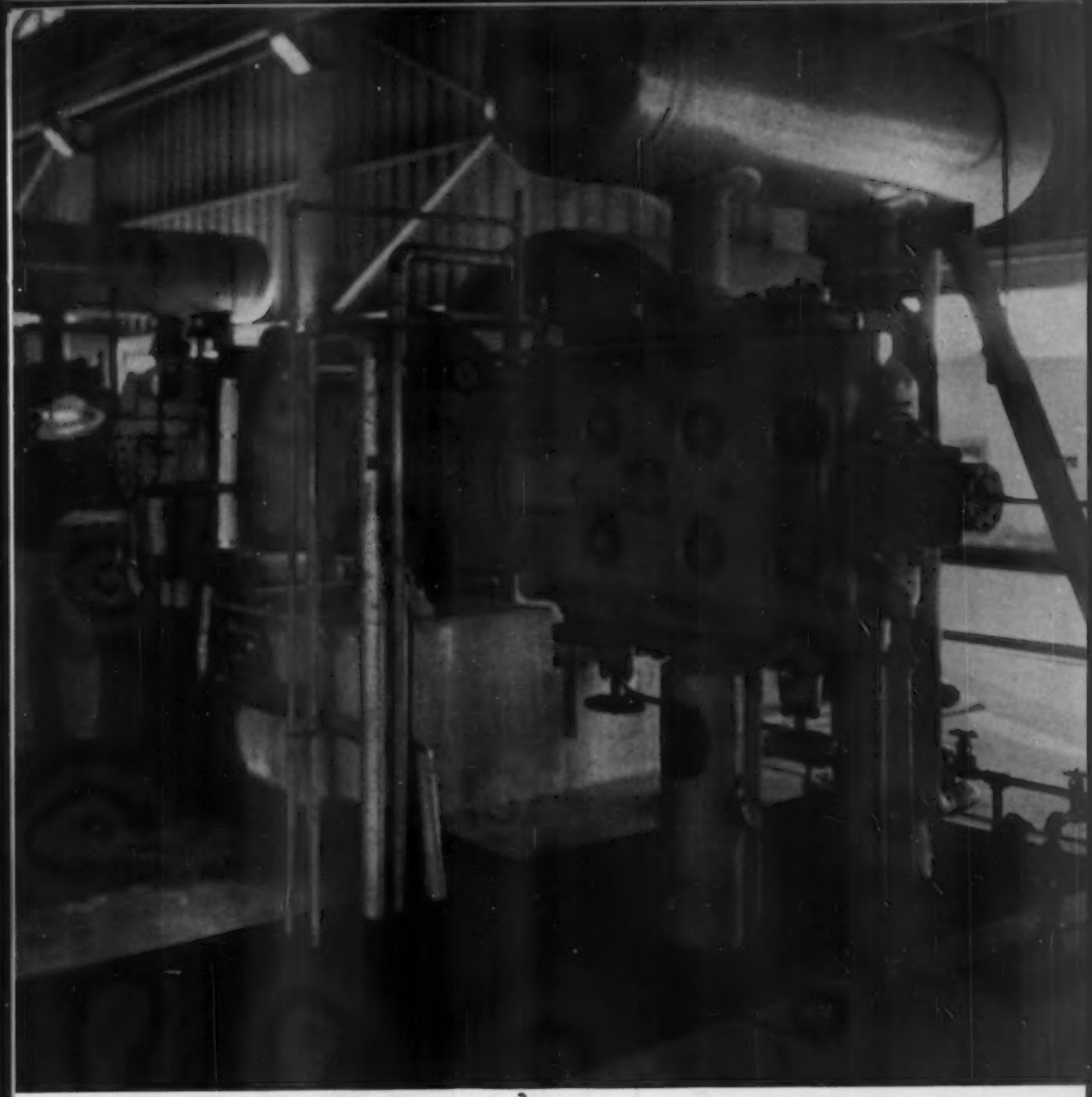
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL, ENGINE, TURBINE OR MOTOR DRIVEN



Cooper-Bessemer FM-2 Hydrogen Compressors at Tidewater Refinery. Rated 690 cfm, suction 470 psi, discharge 800 psi.

Three Cooper-Bessemer Air Compressors at Tidewater. They supply utility air at about 120 psi for processes throughout the refinery.

Let's go after the

J. P. CHAMBERLAIN, P. E.

MEET THE AUTHOR

J. P. CHAMBERLAIN is chief engineer for Delta Refining Company, Memphis, Tennessee, where he has charge of design, maintenance, and construction. He is a graduate of the University of Wisconsin with a BS in mechanical engineering. Prior to joining Delta in 1955 he had eight years' diversified petroleum refining experience with Standard Oil Co. (Indiana), The Pure Oil Co., and Derby Oil Co. Chamberlain is a registered professional engineer in Kansas, Texas, and Tennessee.

HOW MUCH VIBRATION can pipe stand . . . before it is considered excessive? This is a point of much controversy. Many experienced plant people feel that an amplitude of 1/16 in. in pipes above 12-in. diam inside of a building or ¼-in. outside or in an open structure should be the limit. For lines 8 in. and under it should be limited to ⅜ in. In establishing the above amplitude valves the psychological effects were ignored. Frequently a safe but oscillating line will so unnerve the maintenance and operating personnel that costly steps must be taken to reduce the oscillation. For this reason it is important that plant personnel better understand vibration.

Let us now look at vibrations. We can classify them in three categories according to their cause: Free, Forced and Self-excited.

A. Free vibration . . . a system is excited by an external transient impulse usually of short duration. As an example, a heavy truck driving past a pipeline may start it vibrating or a heavy blow or shock might cause it. This type of vibration will subside quickly unless another transient impulse is received because of the natural damping which exists in all piping.

B. Forced vibration, the system is excited by an external source one of a rhythmic nature. Such a rhythmic or periodic force might be caused by the unbalance of rotating machinery such as pumps or motors or the mass unbalancing of reciprocating machines. In addition fluid flow characteristics are frequently encountered which will cause the necessary periodic force sufficient to cause vibration. As an example in a reciprocating compressor, pressure variations caused by the pistons compressing the gases, or in a reciprocating pump water hammer caused the accelerating surges. Luckily for the refiner this latter cause is being reduced as more and more centrifugal pumps are being used.

C. Self-excited vibration, the system oscillates under no periodic external force, and the vibration persists due to internal sources of energy even in the presence of the systems natural damping. Vibration of this type which everyone

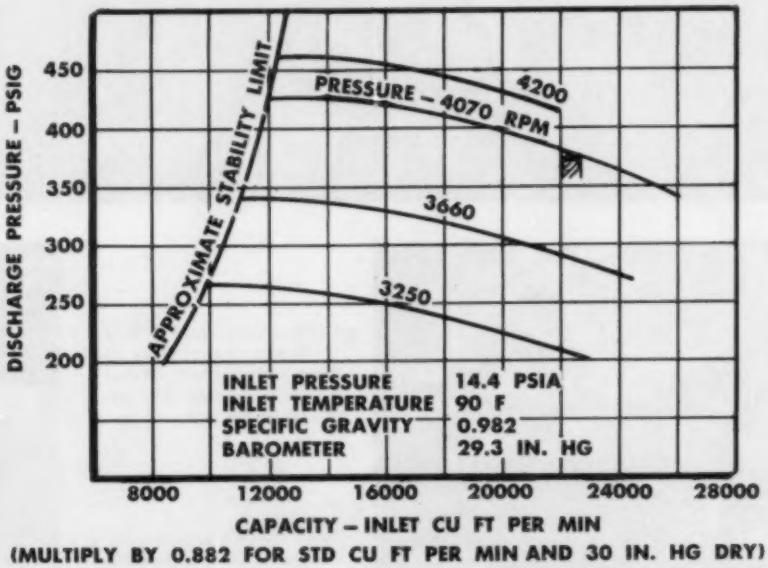


FIG. 1. Performance curve for the turbine-driven centrifugal blower shown in Fig. 2.

cause of piping vibration

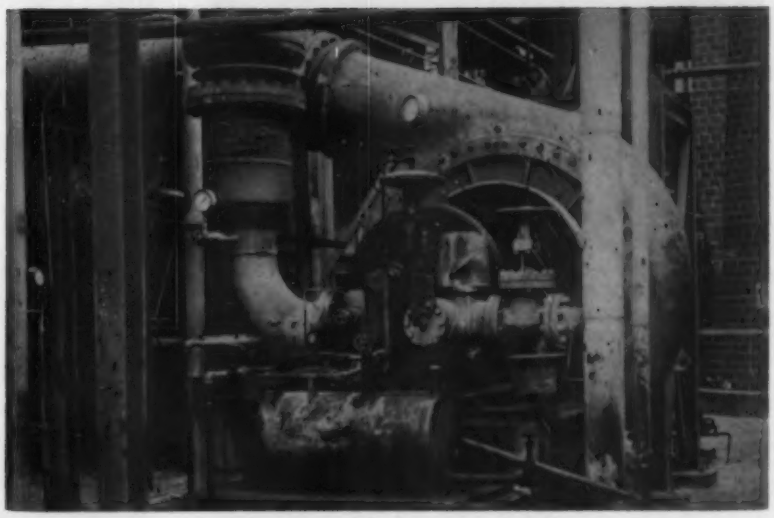


FIG. 2. A centrifugal blower, steam turbine driven, handling air to a Thermal Catalytic Cracking Unit.

has observed is the "singing" of telegraph wires or the chattering of a lathes cutting tool. Flow surges of blowers and fans; airplane wing flutter which recently destroyed two Electras in flight; and combustion instabilities are other examples.

A piping system vibrating under self-excitation is a complex phenomenon, one which is extremely difficult to analyze and one which usually requires experimental investigation. Important causes usually encountered with flow instabilities are surging of compressors due to unsuitable operating characteristics, vortices due to steady wind, and pulsating gas-solid streams.

Fig. 2. shows a large centrifugal blower supplying air to a TCC Unit. This blower rated at 22,700 cu ft per min and 3.75 psig performs exceptionally well and requires little maintenance. But during unit start up or upset when little air is being used it will vibrate badly. This is self-excited vibration due to flow instabilities. Fig. 1 shows the design curve for the blower with the area of instability marked.

This example is important. All machines have a critical band or operating point. If we are to operate near or in this zone for an extended period of time something must be done to eliminate the chance of damage to the machine or associated piping, if they are vibrating. In the case of the centrifugal blower this was an easy task. A portion of the air was vented to atmosphere through a butterfly valve operated from the control board.

Another example of self-excited vibration correction is a 4 ft-6 in. ID by 88 ft-0 in. Isostripper tower equipped with damping devices. These damping devices (shown in detail in Fig. 3) consist of 2 angle iron frames extending out from near the top and the bottom of the tower supporting a ½-in. steel cable. This cable is attached to the tower near the top with a gusset down and out to approximately a 45° angle over the top frame straight down over the bottom frame and then angles back to the tower at another 45° angle. It is then attached to the base of the tower through a heavy spring. Three such devices are installed on this tower on 120° centers.

This type of damping device serves twofold. Not only will it tend to reduce vortices due to the wind but adds additional damping to the tower should it begin to oscillate. The forcing frequency produced by the wind on such a tower can be determined by the following formula:

$$f = SU/D$$

Where:

f = frequency (cycles/sec)
S = Strouhal Number = .18 for a cylinder
U = Wind velocity (ft/sec)
D = Tower diameter (ft)

Of all the vibrations encountered those associated with reciprocating compressors appear most frequently. In one plant the machine foundations were inadequate on a group of cross-compounded steam and electric-driven compressors. This resulted in damage to the machines and cracking of the compressor frames. In another there were underground water lines which ruptured adjacent to the compressor house. This particular unit was a World War II installation and the underground water service lines were asbestos cement pipes. These lines were relatively maintenance free throughout the process area except immediately adjacent

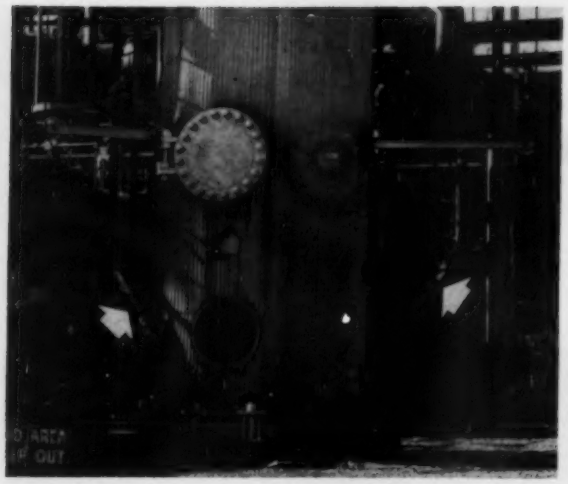


FIG. 3. Detail of spring-loaded damping device installed on 4.5 ft ID Isostripper 88 ft high.

to the compressor house. In this area they were continually rupturing from the ground vibration produced by engine-driven reciprocating compressors. Eventually all of the service lines near the compressor house had to be dug up and replaced with cast iron pipe.

In two other plants there were excessive piping vibrations. One of these two was Delta's Memphis Refinery. Originally we had two 4-cylinder compressors handling gas from our TCC. These two compressors could not handle the load so a 6-cylinder was added. At the time the six-cylinder compressor was added excessive vibration was noted in the suction line to the machine. This vibration was reduced to a safe level by the installation of an adequate anchor imbedded in concrete. This anchor is shown in Fig. 4. The anchor illustrates a method by which excessive vibration is often eliminated. However, isn't it better to eliminate the cause instead of trying to cure the effect? In this respect, let's look at a specific case. As mentioned a 6-cylinder compressor was added to two existing 4-cylinder machines. Then in 1957, the Gas Concentration Unit was rebuilt and a fourth and still larger compressor was added . . . an 8-cylinder. This revamp also included new interstage condenser and a new final compressor cooler.

The final stage cooler consisted of two shell and tube units in series. It operated at 200 psig and handled off-gas from the gas plant stripper and the rich oil from the bottom of the primary absorber . . . in addition to the gas off the final stage of compression.

These coolers were of special construction. The tube baffles were ½ in. thick with tube holes having a tube clearance of 1/64 in. instead of the normal ¼-in. baffles with tube clearance of 1/32 in. These bundles were constructed so as to prevent cutting of the admiralty tubes (as had occurred shortly after the original gas plant had gone onstream and before the installation of the third compressor).

Vibration in the piping around the compressors was noted after the Gas Plant revamp and the installation of this equipment, but it did not appear to be excessive. In fact all of the equipment appeared to be performing exceptionally well. But in less than one year the compressor final coolers began to leak. In fact the inlet exchanger leaked so badly that a new bundle had to be installed. Upon inspection it was found that the tubes in the center of the bundle were cut through at the baffles. Finding this, it was decided to have one of the various companies who sell pulsation snubbers come in and make a survey.

Fig. 5 shows the equipment used in making the pulsation survey.

The procedure in making this survey was to attach the pressure pickup to a ½-in valve on the suction and discharge piping of each compressor cylinder on the 4-cylinder machines which had only one high-pressure and one low-pressure compressor cylinder; and to the lines immediately adjacent to the suction or discharge surge bottles on the 6-cylinder and 8-cylinder machines which had compressor cylinders operating in parallel. In addition readings were taken on the suction and discharge headers wherever valves were available.

Fig. 6 shows a typical trace obtained on the oscilloscope as recorded by the camera. You will note that this photograph is a mirror photograph and therefore is reversed. This particular trace was obtained from the second-stage discharge lateral of compressor No. 4 (8-cylinder machine) with the compressor operating at maximum speed of 600 rpm. The line pressure was 205 psig. The top trace was taken at compressor frequency while the two bottom traces were taken at approximately 1/9 compressor frequency. From these calibrated traces it was determined that the peak-pressure change was 26 psi.

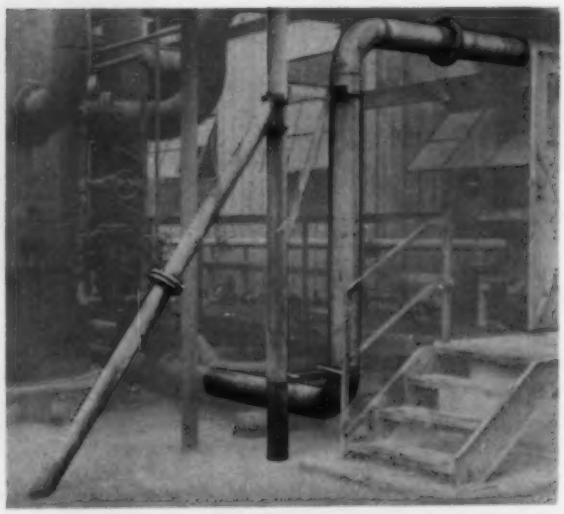


FIG. 4. "Tying down" a suction line to a reciprocal compressor retards the effect . . and can sometimes hide the symptoms of further trouble.

A summation of the peak-pressure recorded during the survey is shown in Table 1. From this table note that one small compressor (No. 2) was not required to handle the load with the other compressors operating at top rpm. This is the case during normal operation as one small compressor is normally off line. In this table all of the readings except those taken on the first-stage suction lateral are above 5%

Table 1.

Description	Pulsation in % of Absolute Line Pressure Compressor No. 1	3	4	
1. 1st Stage Suction Header				4.3
2. 1st Stage Suction Lateral	5.0	4.0	2.5	
3. 1st Stage Discharge Lateral	27.2	22.6	17.8	
4. 2nd Stage Suction Header				12.0
5. 2nd Stage Suction Lateral	13.0	17.0	15.5	
6. 2nd Stage Discharge Lateral	14.7	14.7	11.8	

of the absolute line pressure which is generally considered to be excessive. Readings between 3 to 5% are considered borderline cases.

As a result of the above survey it was recommended that a pulsation snubber be installed on the suction and discharge of each stage of each compressor. Because of cost this recommendation was not followed completely. Snubbers were installed on second-stage discharge piping only. This installation reduced line vibration noticeably.

Table 2.

Description	Pulsation in % of Absolute Line Pressure Without Snubber (5-8-59)	With Snubber (Present)
1. 2nd Stage Discharge Lateral Compressor 2	(14.7)*	1.8
2. 2nd Stage Discharge Lateral Compressor 3	14.7	1.7
3. 2nd Stage Discarge Lateral Compressor 4	11.8	1.1
4. 2nd Stage Discharge Bypass Compressor 4	.....	1.1

*Compressor 1

But, additional tube leaks developed in the compressor final coolers before discharge snubbers could be installed and increased after their installation. During a turnaround each tube in the exchangers was individually tested at 500 psig and all leaky tubes plugged. After coming onstream, additional leaks developed.

Because of these new leaks, a second pressure pulsation survey was requested to determine if additional snubbers were required to protect the final cooler. This second survey was conducted with the same equipment and in the same manner as the first except it was limited to the second-stage discharge piping only. A summation of this survey as compared with the first is shown in Table 2.

In every case the percent of absolute line pressure pulsation was practically eliminated and was way below the allowable 3% level. No new recommendations were made as a result of the second survey. It was felt that the additional tube leaks were caused by fatigue or cut tubes which had been damaged before the snubbers had been installed. Currently we are building replacement bundles — ones with relatively soft baffles which will not harm the admiralty tubes. Some plants with coolers in similar service have gone to a plastic-impregnated cloth baffle to eliminate similar difficulty. Others have installed two sets of coolers with adequate valving so that one set can be cleaned and repaired without shutting the unit down.

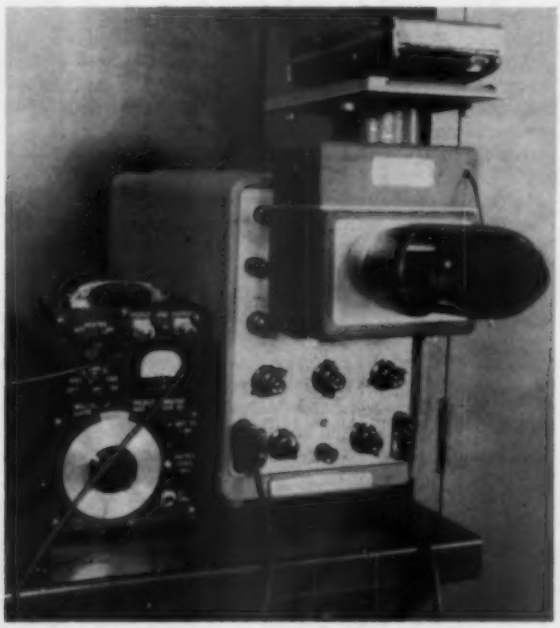
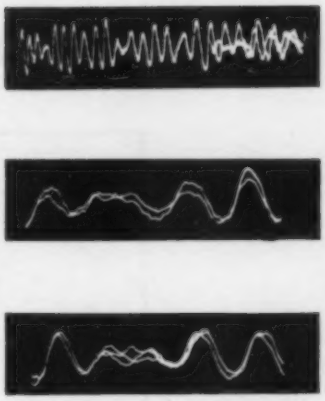


FIG. 5. Instruments used in making the pulsation survey.



LOCATION 20
2nd Stage Discharge Lateral Compressor No. 4

RPM: 600
Line Pressure 205 psig

Peak Pressure Change:
Maximum: 26 psi

Bottom two traces at Compressor Frequency.

Top trace at approximately 1/9 Compressor Frequency.

FIG. 6. Oscilloscope trace curves observed at location 20 in the survey. This was the 2nd stage discharge lateral on compressor No. 4 turning at 600 rpm. The line pressure was 205 psig. Peak pressure changes were 26 psi.

For you who have vibration problems, try to reduce them in the following order:

A. Minimize the cause of the pulsation at its source by the balancing of machinery, installation of snubbers and/or pulsation bottles. A rule of thumb for a snubber is that the chamber should be 10 times the compressor piston displacement per stroke.

B. Control the movement of the pipeline by limiting devices and the addition of dampeners to dissipate the energy.

C. Install rigid anchors to prevent deflection or rotation.

D. Modify the natural frequency of the pipeline or its supporting structure.

For those who are designing piping layout try to eliminate vibration difficulties by making special studies of all piping around reciprocating compressors. Refer the piping and machinery foundations back to the compressor manufacturer for his comments. Piping in connection with simplex pumps or any piston or plunger pump operating at high piston speeds should be studied carefully as they will likely give trouble. Try to avoid horizontal 90° bends where the ell is cantilevered over. In such cases install a support under the elbow. On long vertical lines support at top, or bottom dampen vibration by means of pipe guides or spring hangers. If in doubt about any line, ask for advice from one of the manufacturers who make and sell pipe hangers.

Vibration in pipelines and associated structures is very complex. The designer in order to deal with vibration problems must use sound judgment based upon experience in making simplifying assumptions as there is no general analytical solution available. For this reason we have not tried to give any of the mathematics of vibration. For those interested in a more detailed study of vibration, refer to *Mechanical Vibrations* by Hartog, *Design of Piping Systems* by staff of M. W. Kellogg Co. and *Kent's Mechanical Engineers Handbook*. ★ ★ ★

instrument maintenance "backtalk"

CLARENCE R. SKALNIK

MEET THE AUTHOR

CLARENCE R. SKALNIK, a senior construction and maintenance engineer at American Oil Company's Texas City refinery, has been engaged in instrumentation work since 1951. For four years he served as design coordinator in charge of plant instrumentation, electrical, and air conditioning design, and for the past year he has been coordinator in charge of outside battery limit facilities engineering construction and maintenance inspection. Skalnik has been with the Amoco refinery since his graduation from Texas A&M College with BS in mechanical engineering in 1947. He is immediate past president of the Galveston County Chapter of the Society of Professional Engineers, member of the Houston Section of the Instrument Society of America, and education chairman of Region 7, Instrument Society of America.

EVERYONE is blessed with 20-20 hindsight . . . but who has the time to look back these days? We instrument people have a favorite term called "feedback." It has a definite technical meaning in our jargon, but let's use it loosely to mean "getting information back to the originator of action (the design engineering specialist) so he can evaluate and make necessary corrections to get the desired results." Feedback doesn't mean "lookback" . . . but rather supplementing design know-how with technical communications from areas often overlooked. Let's go into some of these areas . . .

New instruments seem to pop up daily in this age of inventive genius. Marvels of all types offer you design engineers an almost unlimited choice of goodies for application to the hydrocarbon process industry. Unfortunately too many of the so-called instrumentation journals devote most of their material to the jet aircraft and missile fields. The quandry this imposes on you buyers who are looking for the best instrument for a specific application in hydrocarbon processing can be appreciated.

New instruments as such do not cause complaint. After all, progress must be served. However, consider the problem of maintenance when an instrument is the only one of its kind in the plant.

Usually there is little time to get acquainted with the monster before it is pressed into service. New instruments generally have slow deliveries. This means everything else is ready, and no sooner does the instrument enter the plant than it is on its way to the jobsite.

Give maintenance advance warning, if you contemplate buying an unusual item. Once the new instrument is selected — maintenance planning begins. The first phase is a familiarization and training session for the technician who will maintain it. Training is expensive and must be well planned to gain maximum efficiency. It is necessary to get complete manufacturer's detailed drawings as far in advance of instrument delivery as possible. Also, in our opinion, it is desirable to favor manufacturers who have local offices in close contact with their maintenance experts. In this way, a large part of the training can be given by the people most familiar with the instrument and its application to the hydrocarbon process industry.

Manufacturers do a lot of research in developing trouble-free devices. They try to get all the bugs worked out before placing their equipment on the market. But actual service is the most severe critic. A redesigned or new instrument installed in a process can create some interesting experiences if it malfunctions. Operating management can be an unsympathetic lot when a new gadget upsets their unit. Therefore, it may be better to try out a new one in some "harmless" service before promoting it to a responsible position in a control loop.

Usually new devices bring more than their proportionate share of maintenance requirements, at least for a while. As a result, more effort is required by maintenance personnel, and other maintenance must be deferred. The need for ad-

Power Recovery

Licensed by: Shell Development Company

DESCRIPTION: The use of gas turbines to recover power directly from the hot stack gases of a fluid bed process is made possible by installation of a special separator which removes from the gas stream enough of the fine particles escaping from the fluid bed to prevent serious erosion damage to the turbine blading. The special separator design provides adequate turbine protection if the average solids mass velocity as defined below is in the neighborhood of 1 ton per day per ft^2 or less. This number is based on the solids flow rate upstream from the separator (tons per day) and the annulus area of the turbine nozzle blades (ft^2). The mass velocity prerequisite applies to solids having a particle size distribution with 50 percent (weight) smaller than 20 microns. Coarser particles allow correspondingly higher solids mass velocities.

Examples of systems to which the gas turbine power recovery process is applicable are fluid catalytic cracking units in oil refineries and installations for the direct reduction of iron ore in fluid beds. Two typical arrangements for the power recovery gas turbines are shown on the flow diagrams. Fig. 1 shows the use of the power recovery turbine to provide supplemental air to the regenerator of a cat cracker. For those cases where coke-burning capacity is a bottleneck to increasing plant yield, the power recovery turbine-compressor offers the lowest capital cost means of augmenting the existing air supply, and, compared to conventional prime movers, the operating cost is negligible. An extension of this case, which is possible for many cat crackers of current design, is the complete replacement of the steam driven compressor with power recovery turbine-compressors, in effect, producing a power balanced cat cracker.

The flow diagram in Fig. 2 shows perhaps the ultimate power recovery process for a cat cracker, including a supercharged CO-burning boiler. This arrangement offers additional freedom in design and control, since the turbine inlet temperature may be adjusted, within limits, so as to achieve the necessary power balance. Substantial capital cost savings are possible by integrating the regenerator, special separator, pressurized CO-boiler, and turbo-compressor sets all on a common structure, thus eliminating cost items such as long runs of expensive high-temperature ductwork.

ECONOMICS:

The power recovery process offers no product or yield structure improvement; the prime incentives for it stem from capital and operating cost savings. An example of the savings possible by installing power recovery gas turbo-compressor equipment rather than steam turbine driven compressors for a cat cracker regenerator having a coke burning rate of 35,000 lb per hr is shown below.

COMPARATIVE COSTS FOR STEAM TURBINE AND POWER RECOVERY GAS TURBINE DRIVEN COMPRESSORS FOR A CAT CRACKER HAVING A 35,000 LB PER HR COKE BURNING RATE

Steam Turbine Driven Compressors		Power Recovery Gas Turbo-Compressors	
Capital Cost:		Capital Cost:	
Steam Turbo-Compressors	$1,500,000	Special Separator and Gas Turbo-Compressors	$1,500,000
Offsite Utilities (Boiler, Cooling Water)	$1,000,000	Offsite Utilities	None[b]
Operating Cost:	$ 400,000/year[a]	Operating Cost:	None[b]

[a]Based on 5,400,000 hp-hr and stream factor 0.90.

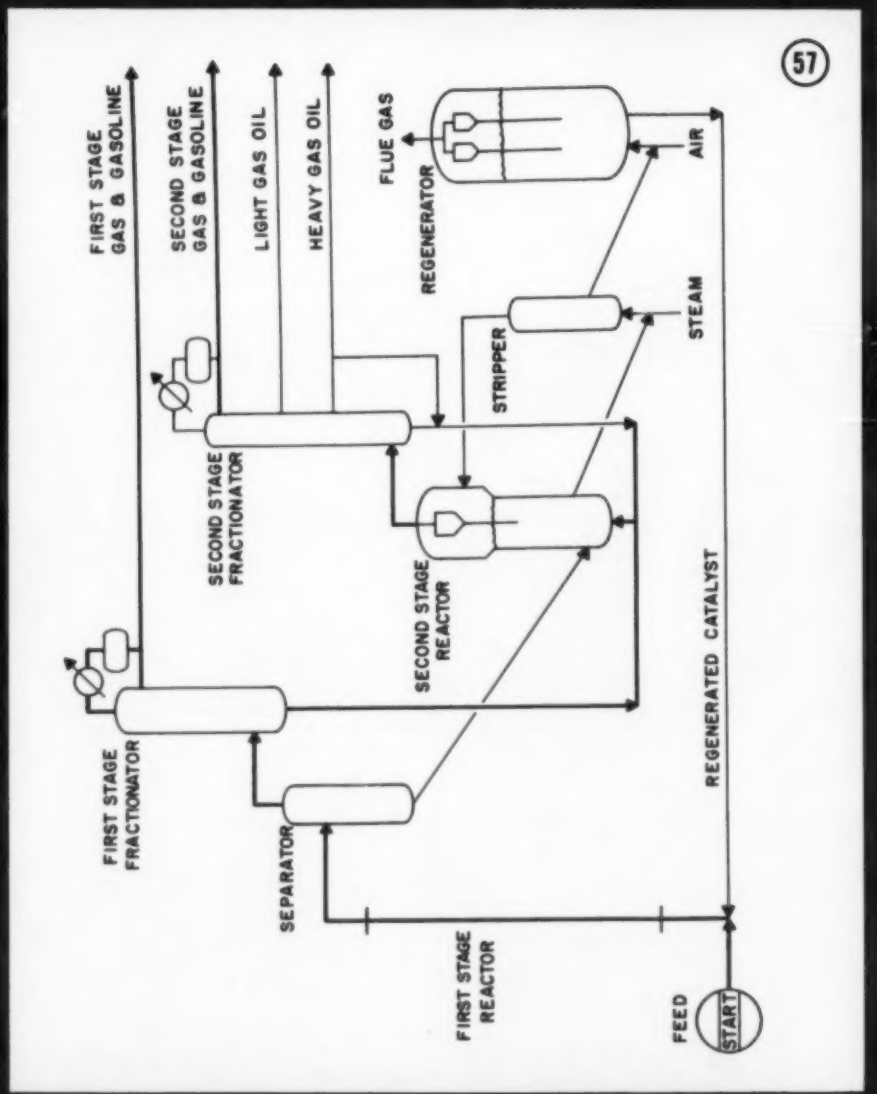
[b]Assuming that 30,000 to 40,000 lb per hr of 50 psig, saturated steam can be made available from other refinery sources during a limited startup period.

ROYALTY:

Paid-up $16 per installed turbine rated horsepower, or $1.75 per standard cfm compressor rated output.

Two-Stage Fluid Catalytic Cracking

Licensed by: Shell Development Company



Two-Stage Fluid Catalytic Cracking

Licensed by Shell Development Company

DESCRIPTION: The feed and hot regenerated catalyst travel concurrently up through a riser. This riser comprises the first-stage reactor in which the retention time is very short. The material from the riser passes into a high-load separator where the partially spent catalyst is removed from the products of the first stage cracking. The latter are sent to a fractionator to remove products that would be destroyed or adversely affected by subsequent cracking.

The unconverted and insufficiently converted hydrocarbons are removed from the fractionator as bottoms and sent to the second-stage reactor. Here the partially spent catalyst again contacts the hydrocarbons and additional cracking is achieved. The vapor from the second-stage cracking is separated by fractionation into the various boiling range products. The spent catalyst is passed to a regenerator and then recycled back to the first-stage reactor riser.

The two-stage fluid catalytic cracking process is used to achieve optimum yields from various feed stocks. When cracking is carried out in one stage the least refractory components are cracked too severely and yield large amounts of gas and coke while the more refractory components undergo only low conversion. This overcracking and undercracking prevents the realization of optimum yields.

The first-stage reactor is operated at high temperatures so that the coke yields are kept low. This condition would have the disadvantage of destructively cracking some of the gasoline components of the charge, if it were not for the very short retention time. By sending the materials from the first-stage reactor to a fractionator, the material that might otherwise be overcracked can be removed from the cracking zones. The more refractory materials can then be given a longer, more thorough cracking in the second-stage reactor.

The catalyst for the second-stage operation is supplied from the first-stage separator. The partially used condition of this catalyst does not hamper the second-stage cracking.

In the two-stage cracking process, considerable flexibility is available for changing the yield structure from a given feed stock. For example, gasoline yield can be increased further by incorporating recycle into one of the cracking stages. On the other hand, in periods of high demand for intermediates, the yield of light gas oil may be increased substantially by charging only heavy gas oil to the second-stage reactor.

Application of the principles described here is not limited to new installations. Existing fluid units can, in some instances, be modified to take advantage of the short-contact-time and the two-stage principles by addition of a riser reactor and accompanying facilities. In cases where high conversion is not required, a single-stage rise reactor unit may be designed to take advantage of the increased selectivity.

The economic advantage of two-stage catalytic cracking over the conventional processes is based upon its superior yield structure, and is most evident at conversions above approximately 60 percent.

APPLICATION: For providing higher gasoline and lower coke yields while permitting greater flexibility for shifting production between maximum gasoline and maximum intermediates.

CHARGE: Conventional catalytic cracking feed stocks.

PRODUCTS: Conventional, but with different distribution.

YIELDS: Commercial operation has been on a mixture of Alberta feeds. The following table gives the properties of the feed and the distribution of the resulting products.

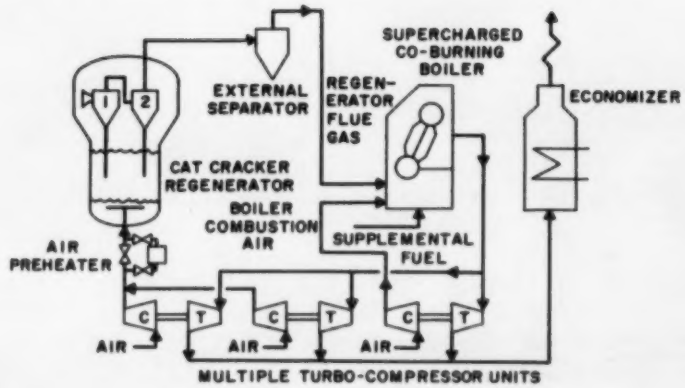
Alberta Feed-Stock	
Gravity, °API	23.7
ASTM Distillation, Degrees Fahrenheit:	
IBP	508
10 percent by volume	620
Pour point, degrees fahrenheit	+85
Ramsbottom carbon residue, percent by weight	0.83
Sulfur, percent by weight	1.26
Viscosity SSU at 210 F	51
Product Distribution, Volume Percent Unless Shown:	
Ethane and lighter (std. cu. ft. per bbl.)	(340)
Propylene	8.0
Propane	4.5
Butylenes	12.7
Butanes	5.1
Debutanized gasoline	53.3
Light gas oil	12.2
Heavy gas oil	12.4
Coke, percent by weight	(6.5)
Conversion	75.4

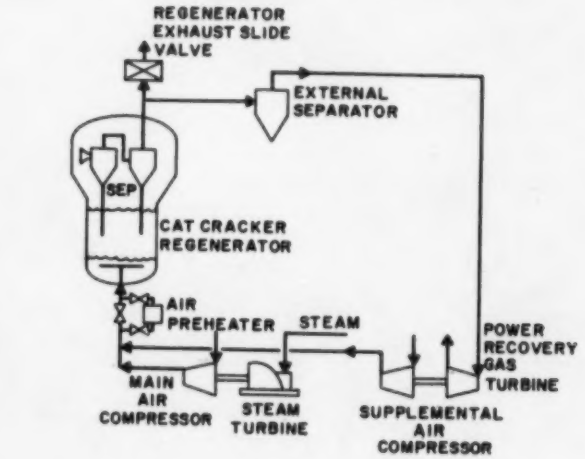
COMMERCIAL INSTALLATIONS:

The first commercial unit employing this new technique was built in Shell's refinery at Anacortes, Washington. This process is licensed by the Shell Development Company through Universal Oil Products and the M. W. Kellogg Company.

Power Recovery

Licensed by Shell Development Company





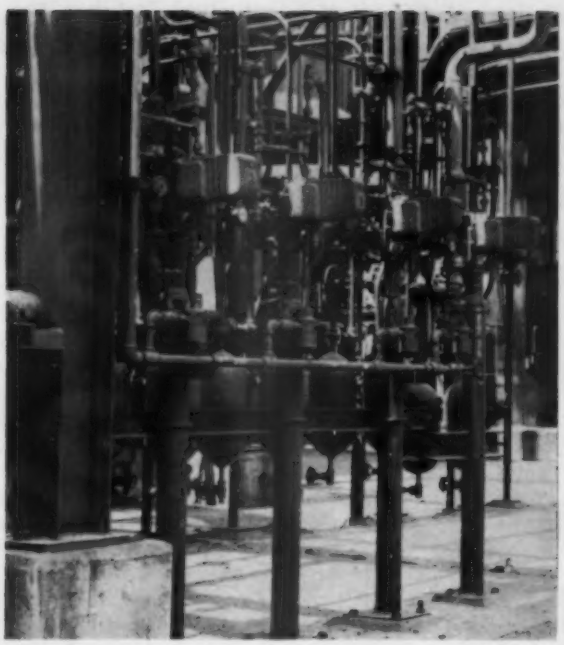


FIG. 1. Flow transmitters at ground level for easy maintenance.

ditional manpower to care for these more complicated instruments is much more difficult to sell to management than the need for more and better instruments. The latter usually can be clearly defined economically, while maintenance manpower requirements are clouded with too many variables.

Replacement parts stock is a factor to be considered in the purchase of a new type of instrument. Maintenance efficiency suffers without adequate spare parts on hand. Replacement parts represent a sizable investment in warehousing, and each type of instrument has its own special variety of parts. For example, the installation of new electronic instrumentation on a 20,000 bbl per day process unit, instead of conventional pneumatics for which a parts stock has already been established, will increase the warehouse inventory by about $5000. The cost of spare parts on hand, warehouse space, and greater warehouse overhead add to the expense of the new instrument. One can see easily where standardization of instruments can be profitable. Naturally, if this is carried to extreme, there will be no progress. But standardization should be a prime consideration from the standpoint of cutting the expense of spare parts as well as eliminating the expense of maintenance training.

Additional help in the spare parts vein is to request the vendor to supply a complete list of parts plus a list of recommended spare parts that should be stocked. These lists should be supplied by the vendor immediately after he receives the instrument order. This will permit the necessary spare parts to be ordered for use when needed.

The maintenance man's safety. It sometimes seems there are only two requisites for a good installation. One is for the instrument to be hooked into the proper place in the process, and the other is for it to be out of the way of the operator. This at times makes for an ingenius compact installation that a stocky 210-lb instrument technician fails to appreciate. Such inaccessible installations are often unsafe for maintenance personnel.

In most instances when an instrument malfunctions, it will be checked out while the process unit is in operation. For some instruments, the mechanic must have access on all sides. This does not necessarily mean foot room all around, but he should be able to view it from all angles. With this in mind, there are a number of potential hazards to consider.

For instance, equipment should not be mounted too near uninsulated hot process lines. In these inaccessible areas, it is a common practice to leave hot lines bare if heat conservation is not a problem. Also, any area that is over 140 F will be detrimental to an instrument. The instrument will be too hot to handle with bare hands without considerable discomfort, and maintenance will suffer.

Another angle on accessibility is the location of instruments just out of reach from safe platforms, or high above the ground where ladders are required. Here the maintenance man exerts more conscious effort trying to keep from falling than trying to fix the instrument. It usually takes just a little more piping to get to a safe area. However, some instruments lend themselves to relocation less readily than others. An example is a displacer-type level transmitter that must be mounted on tower nozzles. A bad installation here must be caught before the construction drawings are issued because a relocation of tower nozzles is usually impractical and a separate platform is expensive.

It is nearly always desirable from the maintenance man's point of view to mount pressure transmitters and differential pressure type flow transmitters remote from the sensing point. The latter preferably should be mounted on suitable pedestals and should be accessible from ground level. This usually adds about $50 to the installation expense for each instrument, which is sometimes difficult to justify economically.

Temperature instruments do not present much of a

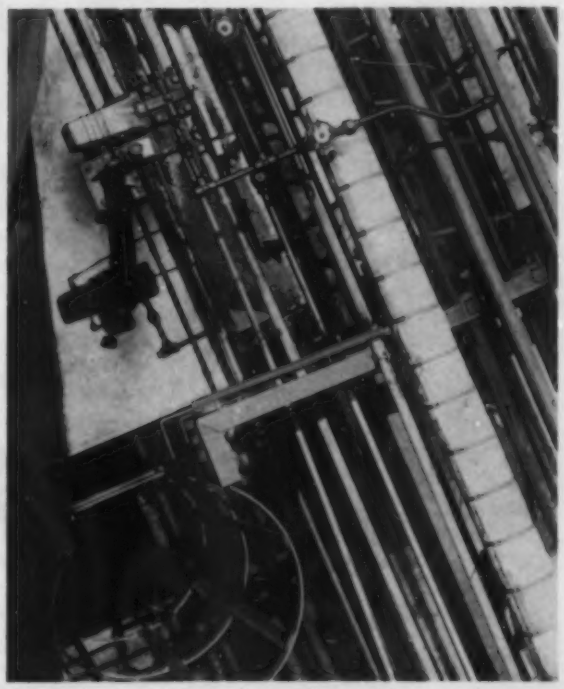


FIG. 2. Flow transmitters in slurry service requiring more than normal attention should be provided with platform, protective hand railing and safety cage ladder. Instrument is over 15 ft above ground level.

CLEAN JET FUEL is essential to safe jet aircraft operation. Today, all aviation fuels in current service may be provided the ultimate protection against fuel contamination. The new Warner Lewis 2-stage separator/filter eliminates jet fuel contaminants — free water and dirt. This new equipment developed by Warner Lewis Company, pioneer manufacturer of separator and filter equipment for aviation refueling, delivers the cleanest fuel ever demanded by commercial or military aircraft. A Silent Servant of Safety, this equipment is installed at the fixed facilities and on refueler trucks and hydrant carts serving most of the world's major airports. It is approved and in production for the U. S. Air Force under recent contracts. For further information, write Aviation Products Division, Warner Lewis Company.

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problem as far as installation is concerned, because with the long lead wires permissible with thermocouples it generally has been convenient to locate the instrument in the control room. However, the bulb type of pneumatic temperature transmitter is mounted in a thermowell in the piping or on the side of a tower. Here advance planning would be required for it to be installed near a platform.

These are only a few examples, but the basic idea is always the same . . . safe accessibility for maintenance.

Another hazard that is easy to overlook is the proximity of instruments to rotating or otherwise hazardous equipment. Sometimes it is tempting to install an instrument where it will form a barrier to keep personnel from accidentally brushing against dangerous equipment. But what about the maintenance man who must cross the barrier while the equipment is operating?

Just like the self-service store manager who discovered the goods that were the easiest to reach usually sold faster than the hard-to-reach items, the design engineer should remember that the easiest and safest instruments to reach will be the best maintained.

Many control rooms are now air conditioned, and in these areas ventilation is not much of a problem. But the hazard can be quite serious if the instrument is mounted near the exhaust of an internal combustion engine, especially if there is no cross ventilation. Also, some industrial process fumes can be just as deadly if ventilation is inadequate.

In our drive for economy, there sometimes is a temptation to eliminate the bleed valve for pressure gages. This is the valve that tees into the piping between the gage and the pressure tap block valve. It is used to relieve the pressure in the piping before the gage is unscrewed. Because there usually is some trapped vapor compressed in the pressure gage, and with the pressure tap block valve closed, any liquid in the connecting piping is apt to spew on the workman when the pressure gage is removed. This practice is not required in water or dry gas service because no hazard exists.

However, one point cannot be emphasized too much: *Please call attention to any piping that is apt to contain hazardous material or skin irritant like acids or caustics.* A special note on the drawing is preferred, but at least a note should be written on the work order calling the hazard to the attention of anyone who may be called upon to disconnect an instrument attached to process piping.

Instrument manufacturers design their equipment to take a great deal of punishment from vibration; however, most of the instruments should be considered delicate. Care should be exercised that they be installed on solid supports, because vibration will inevitably cause excessive wear of linkages and delicate parts. Then it is only a matter of time until excessive maintenance costs creep in. Usually instruments will function satisfactorily for long periods of time even under undesirable conditions, but inaccuracies come in slowly and are not noticed until they become excessive.

Pulsating pressure service. The bouncing needle has become an accepted sight and constitutes a tribute to the rugged construction of the better quality pressure instruments; nevertheless, their useful lives are greatly shortened. Here the liberal use of pressure snubbers can not only make the needle pointer readable, but also minimize wear. Though these snubbers eventually become plugged and also require maintenance, they are much less expensive than the replacement of a pressure element in an instrument or a pressure gage.

Corrosive atmosphere is one of the worst enemies of instruments. They must not only be protected from natural weather elements, but sometimes from cooling tower sprays and chemical fumes as well. We do not have to be concerned with blind pneumatic or electric transmitters because they are usually designed to withstand outdoor use. Also, the pneumatic transmitter has an air bleed inside it that serves as a purge. However, local mounted indicators or recorders which have a hinged front cover and single latch should always be protected from the elements. Otherwise, after prolonged exposure, the gasket surfaces on the door become worn, and rain then freely enters the case. A sheet metal hood usually is considered adequate, but in some areas an enclosed sheet metal house is required.

Ambient temperature. Instruments are usually desgined to operate within a limited ambient temperature range to minimize zero drift. However, below 32 F moist linkages are apt to freeze together, and prolonged exposure to temperatures above 140 F will deteriorate the plastic gaskets and like material more rapidly. Sometimes it is unavoidable for an instrument to be in hot surroundings. Then it is desirable to find the coolest location or, if that is still too warm, to use an air purge. However, sometimes the air purge may "backfire" if the air piping is passed through hot areas for any distance, because the air arriving at the instrument can be hotter than the instrument it is supposed to keep cool.

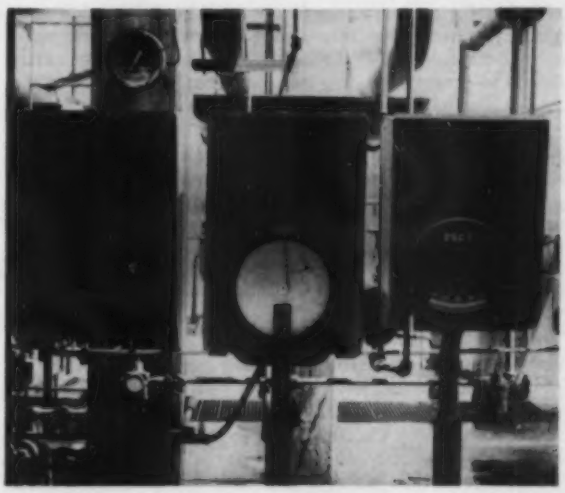

FIG. 3. Instruments of this type with latch covers should be protected by suitable weatherhoods.

Instrument technicians respect instruments as being more delicate than pumps or heat exchangers; however, maintenance people of other crafts do not seem to be aware of this. Instruments located to provide support for temporary scaffolding, to offer a toe hold to a climbing operator, or to provide anchors for shifting equipment will generally be used for these purposes . . . and that's about all they are good for afterward.

Instrument installations should be made in such a manner as to preclude these abuses. No instrument can be expected to last forever, but a little care in selecting its environment will help. ★ ★ ★

Part 2, Chapter 2d—Binary Distillation

DISTILLATION . . . *in view of Modern Developments*

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JAMES A. DAVIES, *Texaco Inc., Houston, Texas*

THE NUMBER OF IDEAL STAGES required for a binary distillation separation is usually calculated graphically. While it is entirely feasible to compute the number of stages for a binary separation stage by stage using analytic equations alone, this is probably never done by hand or by desk calculator. However, in many cases it is rather simple to program a computer to handle a binary using the same steps that one would use in a hand calculation.

Both of the standard techniques for the calculation of a binary system are graphical and will not be derived or presented here in any detail. Each is named after its pair of originators, Ponchon and Savarit for one and McCabe and Thiele for the other. That they are about of equal complexity is shown by the fact that when we teach chemical engineering students both, they usually feel that the one first taught is the easier, more obvious and straightforward, be it the Ponchon-Savarit or the McCabe-Thiele method. The Ponchon-Savarit method is to be preferred for it has no assumptions concerning constant molal overflow and is rigorous no matter how the latent heat changes with concentration and whether or not there is an enthalpy of mixing. It does require a knowledge or approximation of the enthalpy concentration behavior of the system. It can be modified to handle heat leaks, entrainment and efficiencies other than 100 percent. The McCabe-Thiele method is based on the assumption of constant molal flow rate of each phase, vapor and liquid. This will occur if both components have the same molal latent heat of vaporization and there is no enthalpy of mixing. While this is approached in many hydrocarbon systems, it is a very poor assumption in a number of mixtures involving polar compounds. If the latent heats of vaporization are different the method can be corrected by assigning a fictitious molecular weight for one compound so that its fictitious molal latent heat of vaporization is now equal to that of the other component. The calculations are made with the true weight fractions converted to pseudo mole fractions based on the fictitious molecular weight. At the end of the complete calculation the results in the pseudo mole fractions are then converted back to true weight fractions. This still does not allow for the partial molal latent heat of vaporization varying with concentration or for an enthalpy of mixing. The standard Ponchon-Savarit method is rigorous, even for non-ideal systems with the latent heat varying with concentration and with a high enthalpy of mixing. It does have the reasonable assumption that the heat leaks in the column are negligible compared to the enthalpy flow rate. The method can readily be modified to take care of heat leaks.

Both techniques are described in a number of well known texts and articles.[1-5] A distillation man will often use both diagrams in visualizing and examining a problem, for in some cases the effect of varying the reflux ratio becomes a little clearer in a McCabe-Thiele diagram, while the effect of varying heat loads may be more apparent in a Ponchon-Savarit diagram.

Because of the availability of references for the two methods describing the usual situation with both product streams liquid it will not be considered here. Two unusual situations will be covered because methods for them are not readily available. The first is when both product streams as well as the feed are saturated vapor.

Example

It is desired to calculate the number of ideal distillation stages required to separate air entering as a saturated vapor into saturated vapor streams of 98 mol percent oxygen and 98 mol percent nitrogen. The system will be at one atmosphere operating with L/V in the rectifying section 1.3 times the minimum value. (It will be recalled that in commercial operations a double tower arrangement is used rather than this single tower.) For this example, air will be assumed to be 21 mole percent oxygen with the remainder nitrogen. A total reboiler and partial condenser will be used as shown in Fig. 1,

(a) McCabe-Thiele Method:

Following the usual procedure with the necessary assumptions a material balance over an upper section of the column, numbering plates from the top gives

$$y_{n+1} = \frac{L}{V} x_n + \frac{D}{V} y_D$$

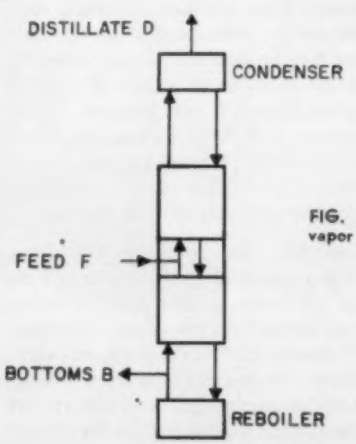


FIG. 1. Distillation column — vapor feed and products.

Similarly for the section below the feed tray

$$y_{m+1} = \frac{L'}{V'} x_m - \frac{B}{V'} y_B$$

As seen in Fig. 2 the intersection of operating lines with the y = x line takes place at the product compositions y_D and y_B. The intersection of the horizontal q-line through the saturated vapor feed composition y_F gives the minimum L/V. After the upper operating line is drawn the lower one is placed and the calculation goes step by step in the usual manner. Nine stages are required between y_B and y_D, one of which is a partial condenser. To calculate the liquid composition in the reboiler, one more step below y_B would have to be drawn giving a total of 10 stages. It is seen that the feed vapor should be added to that coming from plate 4.

(b) Ponchon-Savarit Method:

To allow a step by step comparison with the McCabe-Thiele calculation the enthalpy-concentration diagram is drawn from the same data as the y-x diagram. For this illustration only, the McCabe-Thiele assumptions are made in drawing the diagram, namely there is no enthalpy of mixing and the molal enthalpy of vaporization is the same for each component. The enthalpy concentration diagram can then be drawn with parallel lines at a convenient spacing as in Fig. 3. Notice that values for the enthalpies are not required for the calculation of the number of stages.

The minimum reflux ratio will occur for this system when Δ_D lies on the projection of the tie line through y_F with the line $y = y_D$. This corresponds to

$$\frac{L}{D} = \frac{\Delta_D - y_1}{y_1 - x_c} = 0.612$$

where x_c is the composition of the liquid from the condenser. The equation

$$\frac{V}{L} = 1 + \frac{D}{L} \text{ then yields } \left(\frac{L}{V}\right)_{min} = 0.38$$

Corresponding to $1.3\left(\frac{L}{V}\right)_{min}$ is $\frac{L}{D} = 0.978$

giving the position of the operating Δ_D. The Δ_B is obtained on the projection of the straight line through Δ_D and y_F, H_F to $y_B = 0.02$. The stages are then stepped off in the usual manner.

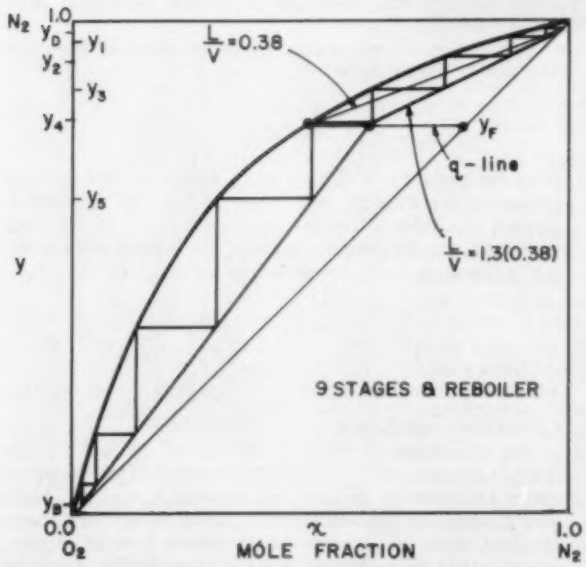


FIG. 2. McCabe-Thiele diagram — vapor feed and products.

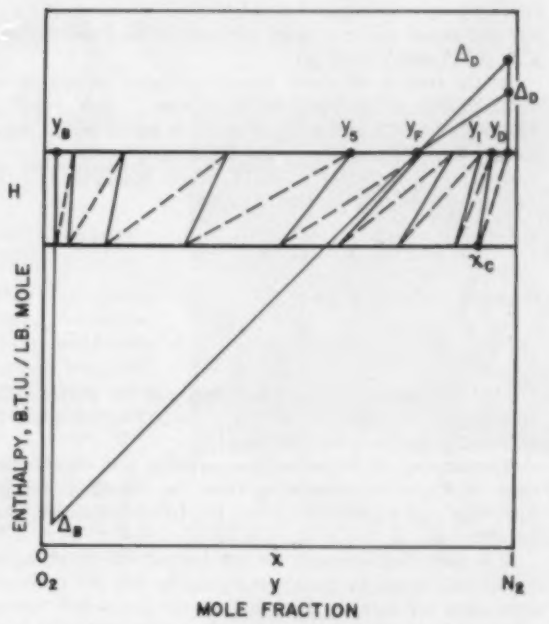


FIG. 3. Ponchon-Savarit diagram — vapor feed and products.

Feed Plate at Non-Optimum Location

In an earlier section of this series it was shown that there are four degrees of freedom or four conditions that can be arbitrarily set in a distillation column. One of these four degrees of freedom normally available is usually taken up by the stipulation that the feed plate be at the optimum location so that the total number of plates shall be a minimum. In most discussions of binary distillation this is an unstated assumption. It is of interest to consider the case where the feed location is at some spot other than the optimum. This is covered in the following example.

Example

A two component system with a relative volatility, α, of 10 is to be fractionated from a saturated liquid feed of 0.5 mole fraction of the most volatile component to a liquid distillate of 0.9 and a liquid bottom product of 0.05 mole fraction of the more volatile component. A reflux ratio L/V = 0.286 will be used and the feed will be introduced on the third plate from the top of a column which has a total condenser and partial reboiler. It is required to find the number of plates for this separation. (It will be noticed that this problem is a step towards the solution of the problem of determining the correct reflux ratio by trial for a given separation in a given column where the feed will not enter on the optimum plate.) It may be assumed that there is no enthalpy of mixing, the molal latent heat of evaporation is the same for each component and hence there is constant molal overflow.

(a) McCabe-Thiele Method:

The equation $y = \frac{\alpha x}{1 + (\alpha - 1)x}$ with $\alpha = 10$ yields the equilibrium curve shown in Fig. 4. Basis, 1 mole feed, F = 1, a material balance with $x_F = 0.5$, $x_B = 0.05$ and $x_D = 0.9$ gives the moles bottom product B = 0.4706 and moles distillate D = 0.5294.

With L/V = 0.286 as given and remembering V = L + D where L and V refer to the moles of liquid and vapor

streams above the feed plate per mole of feed there results $L = 0.212$ and $V = 0.741$.

As the feed is saturated liquid the vapor stream below the feed plate V' is equal to that above $V' = V = 0.741$. The liquid stream below the plate L' is equal to the liquid stream above the plate, L, plus the feed of unity.

$$L' = L + F = 0.212 + 1 = 1.212.$$

The upper operating line becomes

$$y = \frac{L}{V}x + \frac{D}{V}x_D = 0.286x + 0.643$$

while the lower is given by

$$y' = \frac{L'}{V'}x' - \frac{B}{V'}x_B = 1.636x' - 0.0318.$$

The intersection of the two lines can be obtained by equating $y = y'$ giving $y = 0.787$, $x = .05$ which could be obtained from the q-line concept.

By stepping off between the operating and equilibrium lines on Fig. 4 or calculating from the equations for the operating and equilibrium lines, the following values may be obtained: $y_1 = 0.9$, $y_2 = 0.78$, $x_1 = 0.470$, $x_2 = 0.26$.

It is seen that although we are beyond the point where we should switch to the lower operating line for optimum feed plate location the fact that we do not switch has no effect on the operating line. As it is a constant molal overflow system the operating line must remain straight until the feed plate is reached.

The value for y_3 can be read off as $y_3 = 0.715$. The lower operating line may be obtained by a material balance around plate 3, the stipulated feed plate.

$$x_F F + y_4 V' + Lx_2 = Vy_3 + L'x_3$$
$$(0.5)\ (1) + y_4\, 0.741 + 0.212\ (0.26) =$$
$$(0.741)\ (0.715) + 1.212x_3$$
$$\text{or } y_4 = 1.634x_3 - 0.034$$

which is the same as would be obtained from the lower operating line

$$y' = 1.636x' - 0.0318$$

the slight differences being due to the inaccuracy of reading the concentrations from the plot.

The values of the remaining vapor and liquid concentrations are obtained as above: $x_3 = 0.20$, $y_4 = 0.30$, $x_4 = 0.045$.

A minor change in reflux ratio might be made to obtain x_4 exactly equal to 0.5.

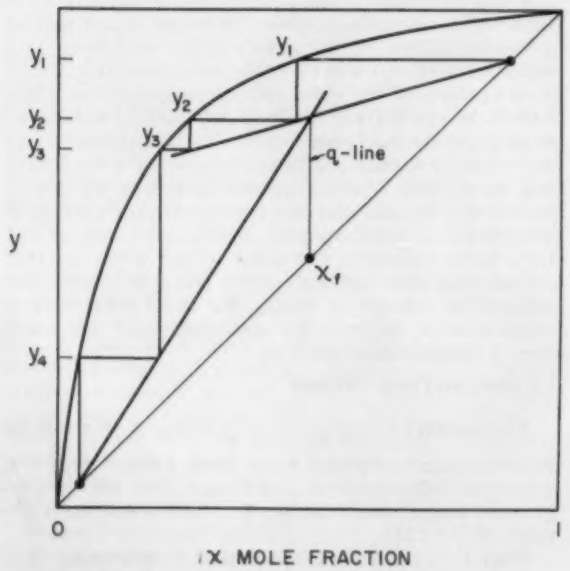


FIG. 4. McCabe-Thiele diagram — non-optimum feed location.

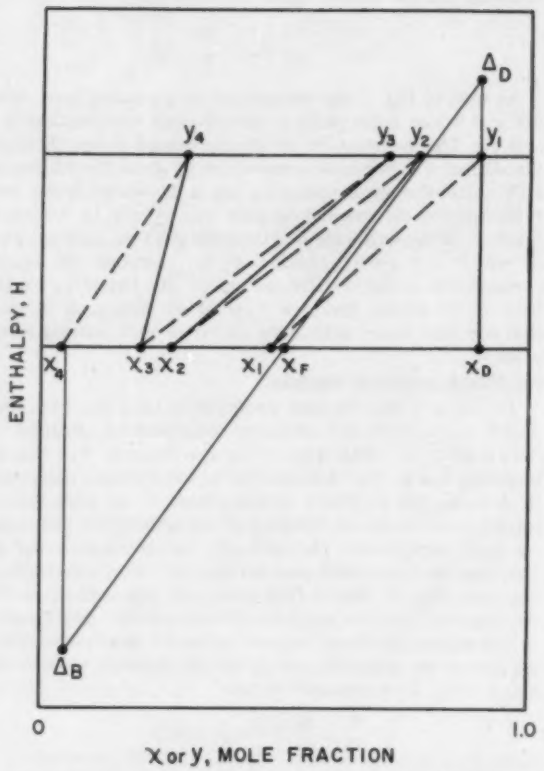


FIG. 5. Ponchon-Savarit diagram — non-optimum feed location.

(b) Ponchon-Savarit Method:

The same problem will be illustrated on the enthalpy concentration diagram. As there is no enthalpy of mixing and the molal latent heat of evaporation is the same for each component the lines for saturated liquid and saturated vapor are parallel. They can be drawn horizontal at a convenient spacing as in Fig. 5.

Substituting the values for L and D obtained from the McCabe-Thiele example

$$\frac{h_\Delta - h_{y1}}{h_{y1} - h_{x_D}} = \frac{L}{D} = \frac{0.211}{0.529} = 0.399$$

gives the enthalpy of the Δ_D point which has the concentration of the distillate, 0.9 mole fraction. By drawing a straight line through the saturated feed point, x_F, H_F and extending it to the composition of x_B the bottom delta point, Δ_B, is found. A check of the lengths of the lines

$$\frac{y_4 - x_3}{x_3 - x_{\Delta_D}} = \frac{2}{3.1} = 0.645 = \frac{B}{V'}$$

which may be compared to $\frac{0.4706}{0.741} = 0.635$ from the McCabe-Thiele calculation.

The calculation proceeds in the normal manner for this method giving $y_3 = 0.715$ at the intersection of the saturated vapor line with the straight line between x_2 and Δ_D. Note that Δ_D must be used rather than Δ_B for we are still above the feed plate. If Δ_B were used a greater gain in concentration would be made for this is the proper place to change Δ points and place the feed plate. Using $\Delta_D x_2 = 0.20$ at

ANACONDA CONDENSER AND HEAT EXCHANGER CLINIC

"Cupralum," lead-surfaced Anaconda copper tube, offers practical answers to some tough corrosion problems

If you'd be interested in more compact, more economical heat transfer units for handling corrosive liquors — sulfuric, chromic, phosphoric acids, sulfites, sulfates, alum, and the like — you should know about Cupralum*. Cupralum, a product of Knapp Mills, Inc., is Anaconda copper or copper-alloy tube to which a uniform, dense-structured, extruded chemical lead surfacing has been metallurgically bonded.

Alfred P. Knapp, chairman, Knapp Mills, Inc., explains to visitors how his company's patented drawing process metallurgically bonds lead surfacing to copper tube.

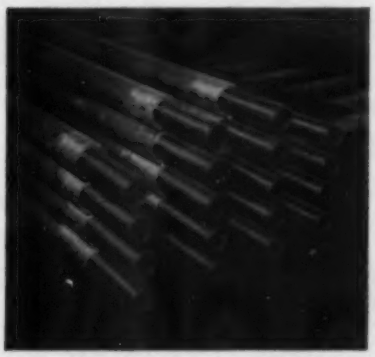
THE OUTSIDE lead surface, which may be from ⅛" to ½" thick, resists concentrations of acids—of sulfuric acid, for example, up to about 85% and up to 428 F. Being bonded to the copper, it expands and contracts with the copper during temperature cycling. Without the metallurgical bond, the lead would creep and eventually fail—an inherent weakness of all-lead tubing.

THE COPPER or copper-alloy tube inside provides strength to make Cupralum self-supporting — and to stand steam pressures up to 150 psi in standard wall thicknesses offered. It also provides its high corrosion resistance internally to cooling waters, steam, and refrigerants.

Most important, copper offers its high heat transfer rate. Because of the metallurgical bond with the lead, the over-all heat transfer rate of Cupralum is high—higher than all-lead tube and higher than that of iron and steel.

THE NET RESULT is that a given heat transfer job can be done with fewer square feet of surface — for a more compact unit. Or it is possible to get increased capacity in present existing space.

Two U-bend Cupralum tube bundles like this are used in a Ferrolum (lead-surfaced steel) separator tower to boil off ammonia from a urea carbonate ammonia solution—in the production of urea fertilizer. Anaconda copper tube core 1" O.D., 12 gauge, handles 150-lb. steam. Lead surface is ⅛ inch thick. Separator tower operates at 145 C (293 F) and 240 psi.

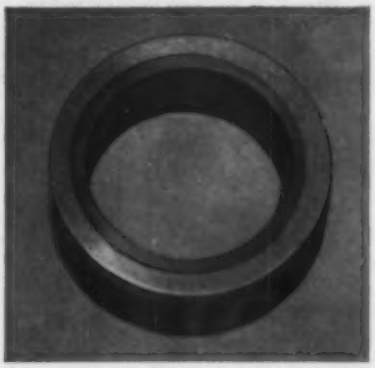


Lead surfacing removed from ends of Cupralum tubes preparatory to insertion in lead-clad steel tube sheet. Tube ends are usually rolled, but for severe thermal cycling service, may be brazed to outer steel face of tube sheet.

In many cases, the first cost of the coil is lower. Usually this is true where higher steam pressures than those previously used are available—or where expensive, hard-to-fabricate alloys have been used. Improvement of the heating or cooling cycle is another source of savings. Under any circumstances, a long operating life and easy maintenance provide over-all economy.

NUCLEONIC APPLICATIONS. Cupralum with a thicker surfacing of lead is being used increasingly in the nuclear industry. For gamma shields that must be cooled, Cupralum coils are built in to provide efficient heat transfer from the shield to the cooling medium.

Where radioactive liquors and spent resin discharge from demineralizers must be conveyed through process piping into process vessels for concentrating the radioactive solution, Cupralum piping prevents the escape of gamma radiation. In nuclear applications, the lead surfacing may be 1" to 8" thick.



Cutaway section of Cupralum tube. It is produced in 20' lengths or in long continuous coils —from 40' to 100' depending on diameter. It is easy to bend and fabricate. Reliable jointing techniques have been developed.

Lead surfaces of Cupralum tubes and of tube sheet are fused by lead-to-lead welding. Then an extra thickness of lead is applied at the joint for extra protection.

FOR MORE INFORMATION. For detailed data on Cupralum, write Knapp Mills, Inc., Wilmington, Del. Or see your Anaconda representative, who can also provide data on the full line of Anaconda copper and copper-alloy tubes—arrange for technical assistance in meeting special corrosion and heat transfer problems. The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 6971

*Registered trademark of Knapp Mills, Inc.

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TUBES AND PLATES FOR CONDENSERS AND HEAT EXCHANGERS

Made by The American Brass Company

the end of the tie line through y_3. This is the feed plate, so all streams below this have the delta point for the bottom of the column, namely Δ_B.

Now $y_4 = 0.30$ on the intersection of the saturated vapor line with the straight line between x_3 and Δ_B; $x_4 = 0.045$ at the end of the tie line through y_4.

Here again a minor change in reflux ratio might be made to obtain x_4 exactly equal to 0.05.

If the feed plate was at the optimum location the calculations would be made in the same manner with the change to the other operating line or delta point coming sooner.

If the methods are not recalled from the above review it is suggested that the references be consulted.

Charge Reflux and Charge Reboiled Distillations

A charge reflux column is so frequently used that a short description should be given. Examples of the use of this type of column were given in the section on Types of Continuous Distillations.

Since the charge provides the only reflux and there is only a stripping section, there are only two degrees of freedom in choosing fractionating variables when the pressure is set. If the bottoms composition is set, as is normal, then the number of trays remain to be determined. The overhead composition will be close to the charge composition, but the bottoms composition can be made to any required degree of purity. The higher the purity, the less the bottoms yield will be. For a given composition of bottoms the more trays that are used, the greater the bottoms yield will be.

An example is shown on Fig. 6. It is assumed that the feed is charged at its bubble-point and constant molal overflow obtains. This diagram shows that three theoretical trays are required and a reboiler. The yield of bottoms product is indicated by the length of the line as shown near the bottom of the graph.

The equation for the operating line, counting the bottom tray as 1, is:

$$y_n = \frac{F}{D} x_{n+1} - \frac{B}{D} x_B$$

A charge reboiled column is similar to a charge reflux column except that the column is all rectifying with the vapor feed at its dew-point. Here the desired product that can be made in high purity is the overhead. Also only two degrees of freedom are available. An example is shown on Fig. 7. It indicates four theoretical trays are required and the line near the bottom of the graph indicates the yield of the overhead. Constant molal overflow is assumed.

The equation for the operating line, counting the top tray as 1, is:

$$y_{n+1} = \frac{B}{F} x_n + \frac{D}{F} x_D$$

It should be noted here that it is incorrect to extend the operating line beyond the intersection of the feed line with the q-line and continue marking off trays as may be done with a column with both a stripping and rectifying section. The material balance equation, i.e., the operating line, includes the feed, and it is also the overall material balance equation.

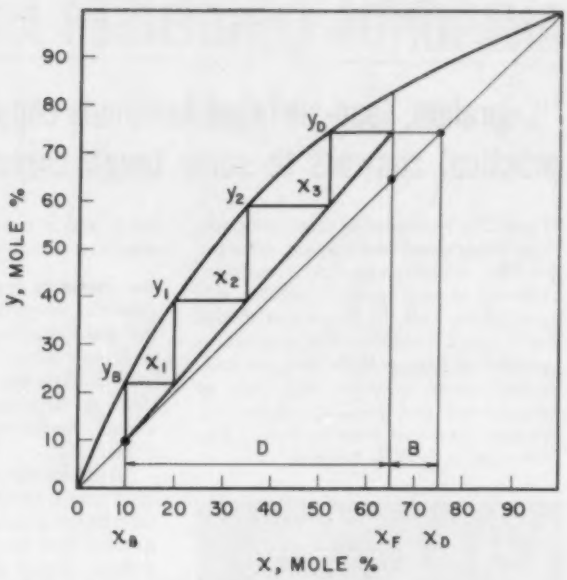

FIG. 6. Charge reflux distillation.

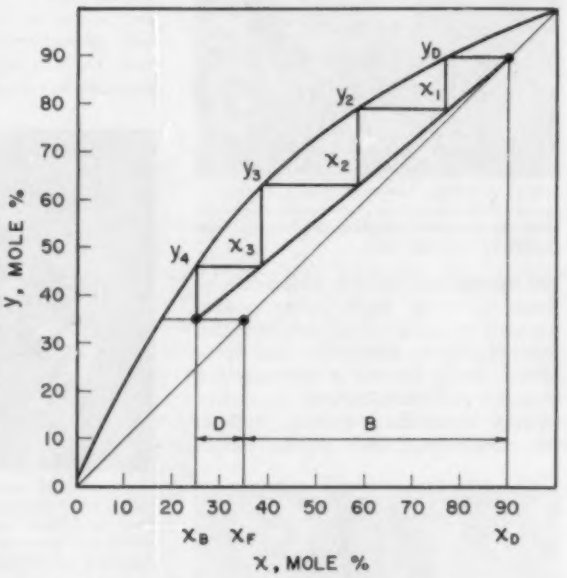

FIG. 7. Charge reboiled distillation.

Nomenclature

- B Bottom product
- D Distillate product
- F Feed
- L Liquid flowrate
- V Vapor flowrate
- x Mole fraction in liquid
- y Mole fraction in vapor
- α Relative volatility

Subscripts

- B Bottom product
- D Distillate product
- F Feed
- n,m Plate number

Superscript

- ′ Stripping section

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3. Edmister, W. C. *Petroleum Engineer*, February pg. 76, March pg. 57 (1948).
4. McCabe, W. L. and Smith, J. C. *Unit Operations of Chemical Engineering*, McGraw-Hill (1956).
5. Robinson, C. S. and Gilliland, E. R., *Elements of Fractional Distillation*, 4th Edition, McGraw-Hill (1950).

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DR. J. M. MARCHELLO, *Oklahoma State University*

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ALGEBRA | *part 4*

THE OBJECT of this chapter is to introduce the principles of exponents and roots and their relation to logarithms.

F. **Exponents, Roots and Logarithms**

It is important to have a working knowledge of the properties of exponents and roots of numbers. For the relationship

$$x^n = a \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

we say that x to the n^{th} power is equal to a. An identical statement is: x is the n^{th} root of a, where n is the power or exponent to which x is raised.

The general rules for exponents are:

$$a^n = a \cdot a \cdot a \cdot \ldots a \text{ (n factors)} \quad . \quad . \quad (2)$$

$$a^m \cdot a^n = a^{m+n} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

$$(a^m)^n = (a^n)^m = a^{mn} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

$$\frac{a^m}{a^n} = \left\{ \begin{array}{c} a^{m-n}, \text{ if } m > n \\ 1, \text{ if } m = n \\ \dfrac{1}{a^{n-m}} \text{ if } m < n \end{array} \right\}, \; a \neq 0$$

$$. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

$$\text{whenever } a = o, \; a^0 = 1 \quad . \quad . \quad (6)$$

These relationships suggest that the operations of multiplication and division may be replaced by the addition and subtraction of exponents. This procedure is extremely useful in many engineering computations and serves as the basic principle behind the construction and operation of slide rules.

To carry out this idea it is necessary to have a more convenient terminology. The name logarithm is substituted for exponent and we say, for example, "the logarithm of 8 to the base 2 is 3," in place of "if we use the base 2 the exponent 3 corresponds to the number 8." Then the logarithm of a number N to the base b is the exponent which must be applied to b to give N or:

$$\log_b N = x \text{ or } b^x = N \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

The oldest or *common* logarithms use the base 10; that is, b = 10. The system of *natural* logarithms employs as a base the irrational number 2.71828 . . . , denoted by the letter e, and uses the notation ln. Logarithms to any base are proportional to the corresponding logarithms to any other base, for example, $\ln N = 2.303 \log_{10} N$.

An example of the use of logarithms in the solution of equations is the calculation of earnings on invested money. If a sum of money, say P dollars, is invested at a rate of interest r compounded annually for n years, the total accumulation A is given by the formula $A = P(1 + r)^n$. If the rate of interest is 5%, how long would it take for the initial investment to be doubled?

Under the conditions of the problem A = 2P, and r = 0.05 so that it is necessary to solve the relationship $2P = P(1.05)^n$ or $2 = (1.05)^n$. Taking the logarithm of both sides of this equation gives $n \ln(1.05) = \ln(2)$ or

$$n = \frac{\ln(2)}{\ln(1.05)} = \frac{0.69315}{0.04879} = 14.2 \text{ years.}$$

Try your hand at Problem 6. Solution will be published in October.

PROBLEM 6

Liquid Level Controller

In making some changes in an existing process it will be necessary to install an unused distillation column from another part of the plant. The column instrumentation is intact with the exception of a bottom liquid level control. The storeroom has a used single speed floating controller on hand and it is suggested that it be used.

The available controller would control the liquid level in the bottom of the column by adjusting the bottoms flow rate from the reboiler. Under normal operation the flow rate from the bottom of the column will be 120 gal per min and the liquid level in the bottom of the column must be controlled within a 6-in. zone. The column is 3 ft in diam. The bottom liquid will be essentially pure toluene.

Investigation of the control unit indicates that the electric motor can completely open or close the 6-in. flow control valve in approximately 20 sec. The minimum neutral zone width that the level controller can be set for is 1 in.

Will the controller handle the job?

Solution to August Problem:

Problem 5. Punching Machine Performance

In the design of punching machines tests show that the work-diagram for steel may be assumed, without serious error, to be equal to triangular work diagram in which the maximum pressure, P, corresponds to the shearing strength of the steel plate, Fig. 1.

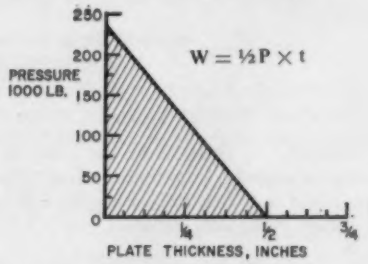

FIG. 1. Triangular shearing work diagram.

The work, W, done in punching a hole is represented by the area under the pressure-thickness line.

$$P = \pi \times d \times t \times 60{,}000$$

$$P = \pi \times \frac{5}{2} \times \frac{1}{2} \times 60{,}000 = 235{,}500 \text{ lb}$$

$$W = \frac{1}{2} P \times t$$

$$W = \frac{1}{2} \times 235{,}500 \times \frac{1}{2} \times \frac{1}{12}$$

$$= 4900 \text{ ft} - \text{lb}$$

This work is supplied by the flywheel and is equal to its change in kinetic energy.

$$W = \Delta K.E. = \frac{1}{2} I (W_2^2 - W_1^2)$$

Where W_2 is the free or initial speed of the flywheel and W_1 is its speed after completing the punch.

The moment of inertia of the hollow cylinder flywheel, neglecting the hub and spokes is

$$I = \frac{1}{2g} M (r_1^2 + r_2^2)$$

where the mass of the wheel is

$$M = \pi \rho h [r_2^2 - r_1^2]$$

$$M = \pi \times 450 \times \left(\frac{4.5}{12}\right) \left[\left(\frac{3}{2}\right)^2 - (1)^2\right]$$

$$M = 660 \text{ lb}$$

Then the moment of inertia of the flywheel is

$$I = \frac{1}{2} \times 660 \times \frac{1}{32.2} \times \left[\left(\frac{3}{2}\right)^2 + (1)^2\right]$$

$$I = 33.2 \text{ slug} - \text{sq ft.}$$

The question of whether the machine can do the job or not can now be answered by considering the work which the flywheel can supply. If the machine stalls during the punching cycle $W_1 = 0$ and the work was equal to or greater than

$$W = \frac{1}{2} I W_2^2$$

The maximum output of the machine is

$$W = \frac{1}{2} \times 33.2 \times \left(\frac{220 \times 2\pi}{60}\right)^2$$

$$W = 8800 \text{ ft} - \text{lb}$$

Since the work required to punch a hole is 4900 ft-lb and the machine can deliver up to 8800 ft-lb the machine has sufficient capacity for the job.

In machine design one usually speaks of the "coefficient of speed fluctuation," that is, the ratio of the speed of the flywheel after punching to its initial speed. The coefficient may be expressed as

$$\alpha = W_1/W_2$$

The value of the speed coefficient for this job can be determined from the work equation

$$W = \frac{1}{2} I W_2^2 (1 - \alpha^2)$$

$$4900 = \frac{1}{2} \times 33.2 \times \left(\frac{220 \times 2\pi}{60}\right)^2 (1 - \alpha^2)$$

$$1 - \alpha^2 = \left(\frac{4900}{8800}\right) = 0.557$$

$$\alpha^2 - 0.443 = 0$$

$$(\alpha + 0.666)(\alpha - 0.666) = 0$$

or

$$\alpha = -0.666$$
$$\alpha = +0.666$$

Since the machine may stall but not reverse its speed by 66.6% the negative root is not physically realistic. The "coefficient of speed fluctuation" for the machine performing this job is 0.666; that is, the speed of the flywheel decreases by 33.3% during each punching cycle.

The punching machine is well designed and it is reasonable to assume that the clutch and pinion gears will handle this work load. The machine can do the required punching job.

Our thanks to Mr. Justus O'Reilly, manufacturing superintendent at Skelly Oil's El Dorado, Kansas Refinery for the following errata: Mathematics Workshop, Page C-31 of the July issue. Equation (2-5) shows "$1.16x_{15}$." This should be x_5. The next line states "Solving Equation 2-2 for the mole fraction of benzene in the liquid." This should be butane rather than benzene.

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another

TRETOLITE SERVICE report

KONTOL *Corrosion Inhibitor permits low pH operation in refinery's crude unit overhead system*

OHIO OIL COMPANY GETS EFFECTIVE CORROSION CONTROL, BETTER PRODUCT QUALITY AT REDUCED COST

An outstanding performance record compiled over a five-year period in Ohio's refinery at Robinson, Illinois, proves the feasibility of low pH operation augmented by KONTOL* Corrosion Inhibitors.

Prior to inauguration of the low pH-KONTOL program, a high (7.5) pH operation on overhead receiver waters was fouling equipment. Heavy sludge deposits were accumulating ahead of exchanger baffles, and ammonia was contaminating hydrocarbon streams. These troubles limited the refinery to short runs at decreased capacity. *In addition, serious corrosion problems resulted in extensive equipment replacement and repairs after only nine months of operation.*

By changing to a low (4.0-4.5) pH and injecting KONTOL Corrosion Inhibitor at a rate of 10-15 ppm, Ohio has stopped sludging and greatly lowered ammonia contamination. Equipment has been kept clean, reducing maintenance costs and permitting longer runs at increased charge rates. Turnaround inspection has been lengthened to 18-month intervals. *No equipment failures due to corrosion occurred during this five-year period.*

Low pH operation supported by KONTOL corrosion control might offer important advantages for your refining facilities. Ask the Man in the Red Car to explain this program, or write . . .

*Registered trademark, Petrolite Corporation

Facilities such as this one for Kontol injection at various points are part of over-all corrosion control program at Ohio Oil Company's Robinson, Ill., refinery.

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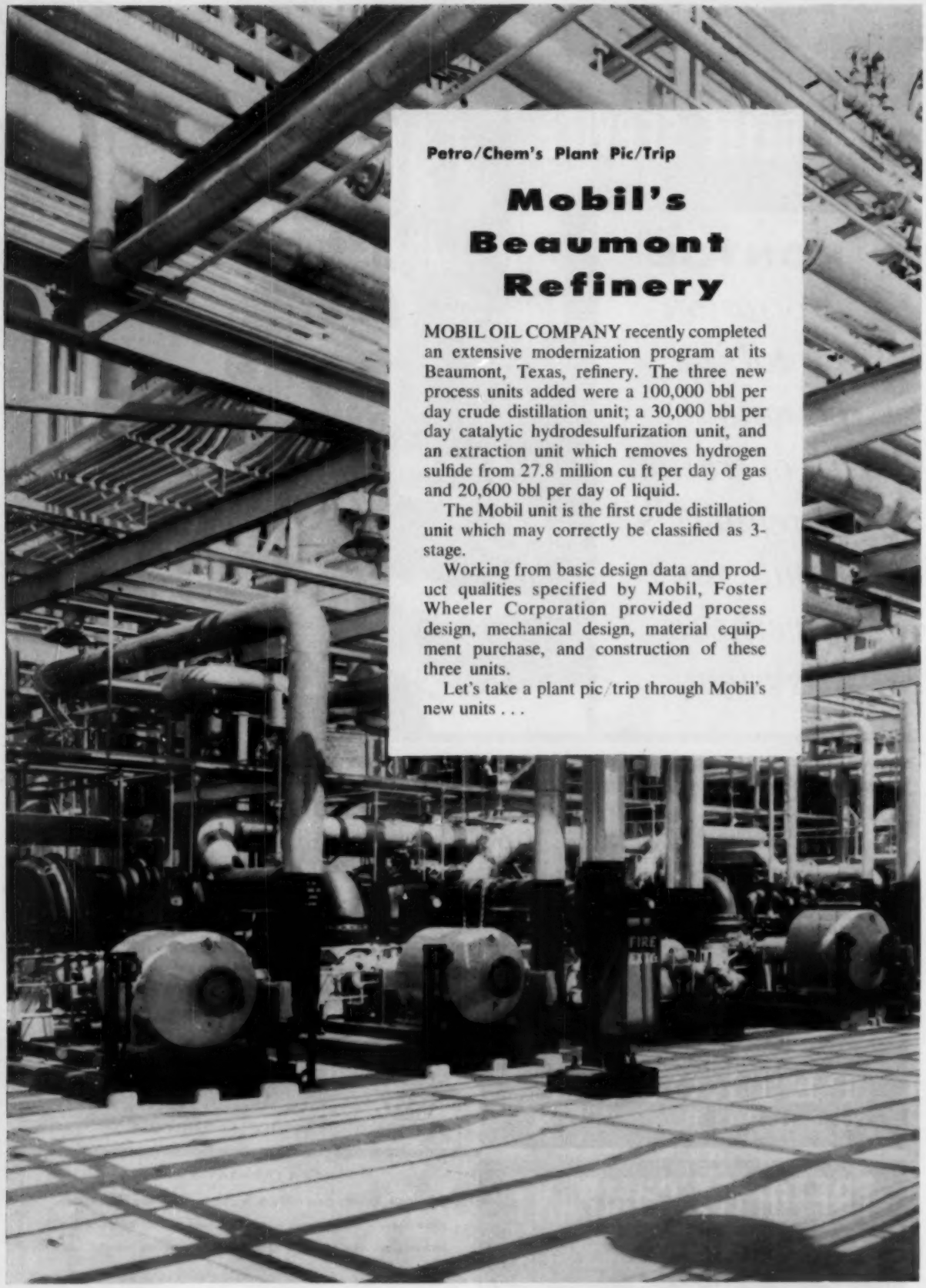


Petro/Chem's Plant Pic/Trip

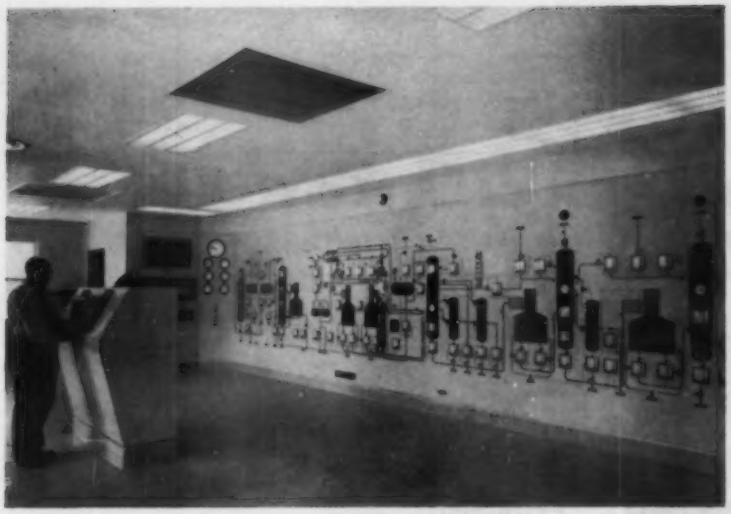
Mobil's Beaumont Refinery

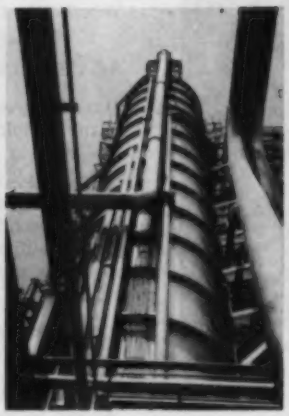
MOBIL OIL COMPANY recently completed an extensive modernization program at its Beaumont, Texas, refinery. The three new process units added were a 100,000 bbl per day crude distillation unit; a 30,000 bbl per day catalytic hydrodesulfurization unit, and an extraction unit which removes hydrogen sulfide from 27.8 million cu ft per day of gas and 20,600 bbl per day of liquid.

The Mobil unit is the first crude distillation unit which may correctly be classified as 3-stage.

Working from basic design data and product qualities specified by Mobil, Foster Wheeler Corporation provided process design, mechanical design, material equipment purchase, and construction of these three units.

Let's take a plant pic/trip through Mobil's new units . . .





IDEA EXCHANGE

Problem • Solution • Results

E. L. Cunningham and C. M. Hatcher, Dow Chemical Company, check nozzle for pipe cleaning job.

PROBLEM:

Cleaning stubborn scale from process lines.

SOLUTION:

A spray nozzle plan to be used in a washing method. Devised by C. M. Hatcher, supervisor, and E. L. (Doc) Cunningham, foreman, Zone 4, Dow Chemical Company's Freeport, Texas, plant. Used in cleaning 3300 ft of 4-in. pipe.

First take a 2-in. bull plug and drill slanting holes around it. Then couple the plug to a flexible rubber hose to carry the water, and hook the operation to a piston-type pump.

Using a mobile 350 cu ft per min air compressor for a source of power, develop enough pressure to jet the water through the hose so that it reaches the nozzle head with a force necessary to clean the scale off inside the line. The spray and pulsations from the pump exert enough pressure to keep the nozzle moving through the pipe, cleaning and washing out the scale as it moves along.

Using this method, Hatcher and Cunningham were able to wash as much as 200 to 300 ft of pipe in one operation, instead of the 10 or 20 ft previously done when the pipe was cleaned in sections.

After completing the 300 ft (limited because of available pressure), the hose and nozzle head were pulled back through the pipe, cleaning out any residue left when the nozzle had moved forward. Then another section of pipe was opened and the operation started again.

This cleaning process meant fewer replacements of pipe and also made the job easier, particularly on the overhead line, which is supported by 20-ft stanchions.

PROBLEM:

Whether to replace or retain long-service tubes.

SOLUTION:

Have tube samples tested in the manufacturer's laboratories. If the samples show significant wear, tests point to prompt replacement, preventing costly downtime due to unexpected tube failure. If tubes are found to be in good condition, premature tube replacement is avoided. Testing tube samples to determine rate of wear and deterioration is one of the lesser known but highly valuable services performed in the tube manufacturer's labs.

EXAMPLE:

In 1955 an East Coast refiner submitted to the Tubular Products division of The Babcock & Wilcox Company, Beaver Falls, Pennsylvania, a 7 to 9% chromium-molybdenum heater tube sample taken from a tube which had been in continuous operation for 14 years. Laboratory tests indicated the tube still met requirements for ASTM Specification A-200-55T, so replacement was not necessary at that time.

Nearly four years later two samples from the same tubing lot were re-submitted for examination. A parallel series of tests was conducted on the new samples, and, where possible, compared to results obtained from the sample submitted in 1955.

Tests conducted were:

- Visual examination
- Chemical analysis
- Hardness readings
- Flattening tests
- Metallographic examination

The tests showed that no microstructural changes except shallow carburization had occurred. No surface damage was observed on the samples. It was concluded, therefore, that the tubes would probably still be satisfactory for normal service despite the loss of some ductility. However, the possibility of hardening the tubes during welding and/or decoking operations was pointed out. Hardening could result in subsequent failure by impact, shock loading, etc., and the carburized areas would be particularly susceptible.

Test results and conclusions were submitted to the customer, enabling him to determine which tubes to replace or retain.

PROBLEM:

Cosden Petroleum Corporation faced the problem of placing an existing 42-in. ID by 15 ft 7-in. high column under an absolute pressure of 4 millimeters of mercury. A preliminary investigation indicated the use of a multistage steam jet ejector system. Existing cooling water facilities prompted the use of surface condensers over barometric condensers. A 4-stage steam jet ejector system with booster condenser and intercondenser was chosen for this service.

The ejector system and the column were to be used in a process which had only been proven on a semi-commercial basis. A minimum of laboratory data was available for sizing the equipment. Under these circumstances, the possibility existed that changes would have to be incorporated based on actual operating conditions.

SOLUTION:

Two possible methods of installation were considered. The conventional approach of building a support structure for the vacuum equipment revealed these disadvantages:

If 34 ft long dip legs were used to maintain the low absolute pressure in the condensers, the supporting structure would have been elevated 18 ft above the vapor outlet on the column. The suction line from the vapor outlet to the booster inlet would have been 23 ft 6-in. long or some 8 ft longer than the tower itself. To pull the booster condenser bundle, an additional platform 18 ft by 6 ft would be required.

It was decided to install the condensing equipment on concrete foundations located at a convenient working height above the existing grade. Fig. 1 and 2 show the plan and elevation of the original installation. The equipment was accessible for maintenance and future changes.

Individual steam control valves and vacuum gages were located on a panel midway along the booster condenser.

There remained the problem of draining the condensate from the condensers. A small water accumulator pot was attached to each of the condensers. An inexpensive gear pump took suction from the accumulators and discharged the condensate to the sewer. This scheme was successful but the pump packing had to be tightened frequently to maintain the low absolute pressure in the condensers.

During three months of operation, additional data was obtained. The process in which this equipment was used proved that it was sound for full scale commercial operation. The demand for increased capacity of the vacuum equipment prompted a re-evaluation of the existing facilities.

By increasing the size of the first stage ejector, intercondenser, and second stage ejector, the hydrocarbon thru-put to the vacuum equipment was raised in excess of 26 weight percent. To make the necessary changes, a new foundation for the larger intercondenser was poured prior to taking the vacuum system off stream.

The water accumulator and pumps were replaced with pumping traps. A trap was located under each condenser. Gravity flow from the condenser shell fills the trap. Gas pressure from an outside source provides the motive power to discharge the trap after it has been filled. An equalizing line between the trap and the condenser provides the means of evacuating the gas used for emptying the trap. The traps have been in service in excess of 16 months with very little maintenance required. Currently both traps discharge into a receiver, allowing recovery of any hydrocarbon which has condensed with the motive steam.

This installation has proved very satisfactory during two years' service.

This problem-solution is from E. H. Boullioun Jr., a project engineer at Cosden Petroleum Corporation's Big Spring, Texas, refinery. He holds degrees in mechanical engineering and business administration from the University of Texas and has been with Cosden since 1954. He is a registered professional engineer in the state of Texas. ★ ★ ★

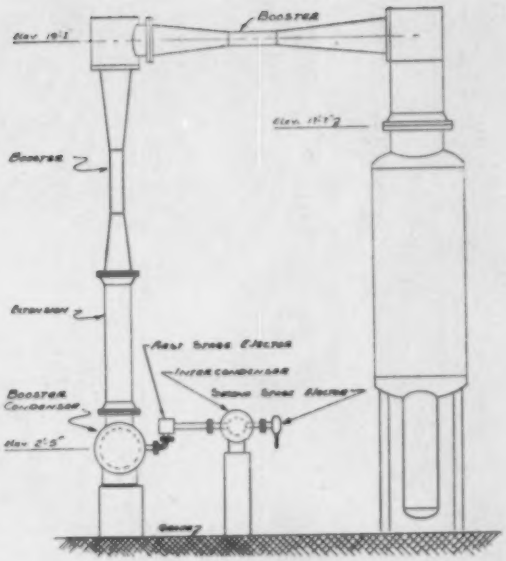


FIG. 1. Plan of original installation.

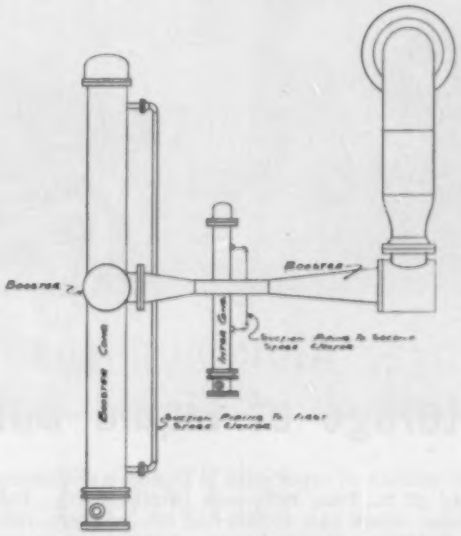


FIG. 2. Elevation of original installation.

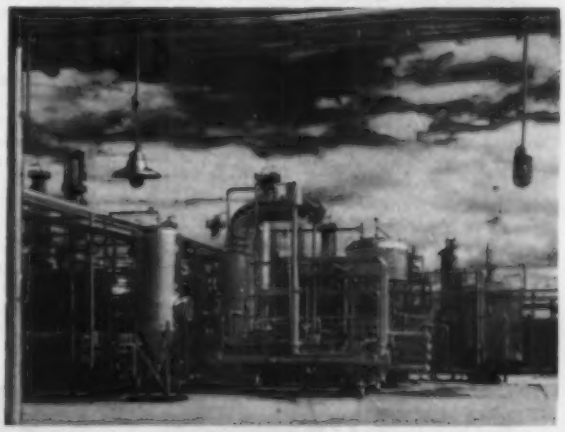
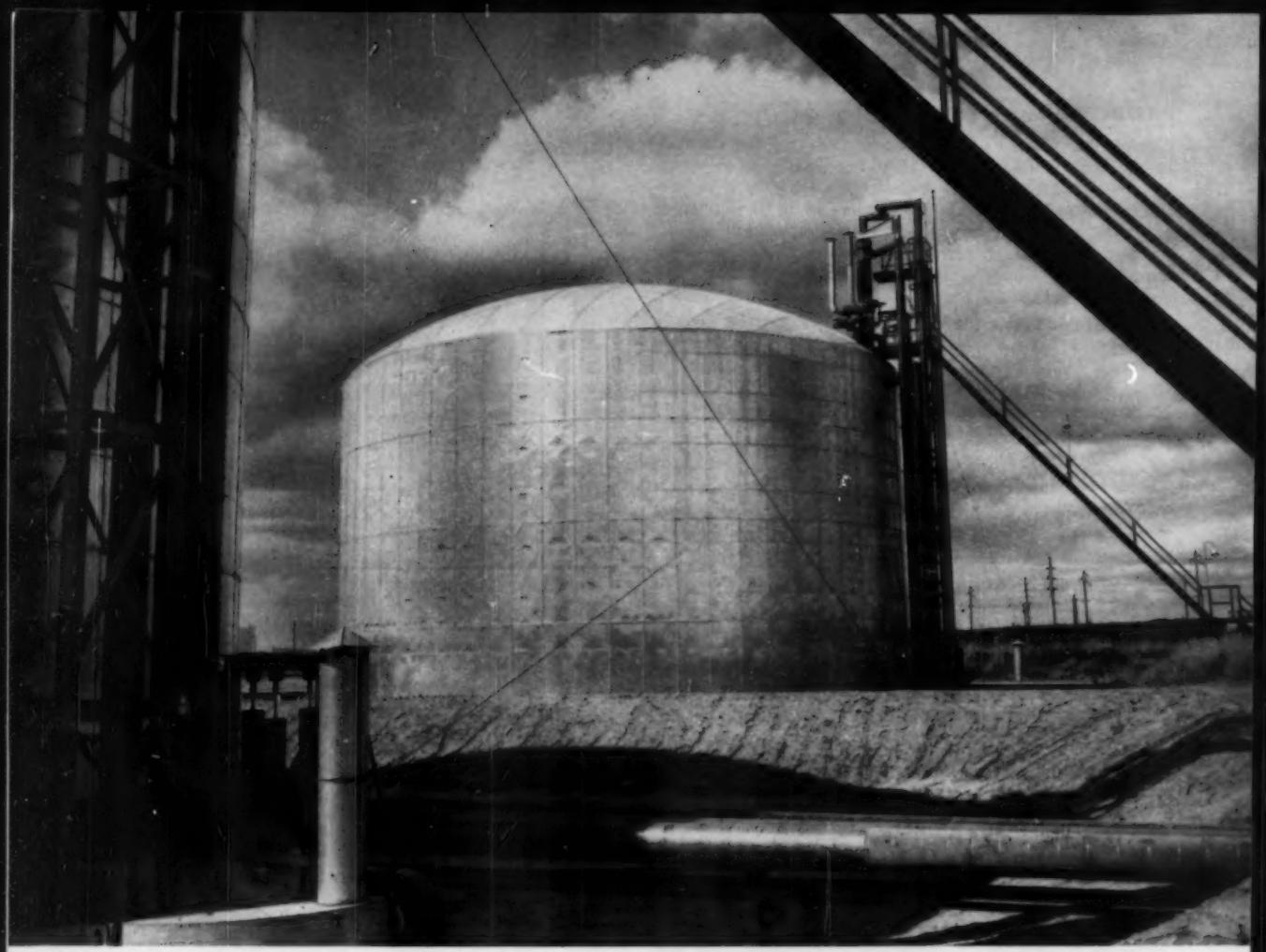


FIG. 3. Vacuum equipment installation. Note the pumping traps on the concrete slab under the condensers.



Novel Aluminum-Insulated Tanks for Double-Duty Storage of Liquid Butane and Anhydrous Ammonia

The science of cryogenics is no more profitably applied than at St. Paul Ammonia Products, Inc., Pine Bend, Minn., where two 45,000 bbl. low-pressure, refrigerated steel tanks with multiwall aluminum insulation were recently placed in dual-service.

During the summer and fall, liquefied butane is stored at +25°F. During the winter and spring, anhydrous ammonia is stored at —18°F. The design pressure, in both instances, is 5 psig.

Thus, in summer when butane is more readily available, the two tanks preserve huge quantities of potential B.t.u.'s in a relatively small area, thanks to storage as a liquid at a low temperature and pressure. The butane is used by St. Paul Ammonia as a raw material for manufacturing anhydrous ammonia, which, in turn, is stored in the tanks for the spring, when demand from fertilizer users is heaviest.

A low operating cost is achieved by a completely automatic system of filling and emptying the tanks. Outer layers of aluminum to reflect the sun's rays provide an insulation that effectively aids in maintaining the desired temperatures. Asbestos Products, Inc., St. Paul, installed this novel insulation.

Designed, fabricated and field-erected by Graver, these two tanks represent one of many types of cryogenic storage and processing equipment Graver has been called on to design and produce. The opportunities for cutting costs and improving efficiency are substantial when the science of cryogenics can be employed. If there is an application in your operation, it will pay you to talk it over with Graver.

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Marketing data include surveys on why motorists buy certain brands, how service station operators can turn customers' car worries into sales advantages, plus many other facts. Fuel and lubricant specialists are also ready to help you sell fleet customers.

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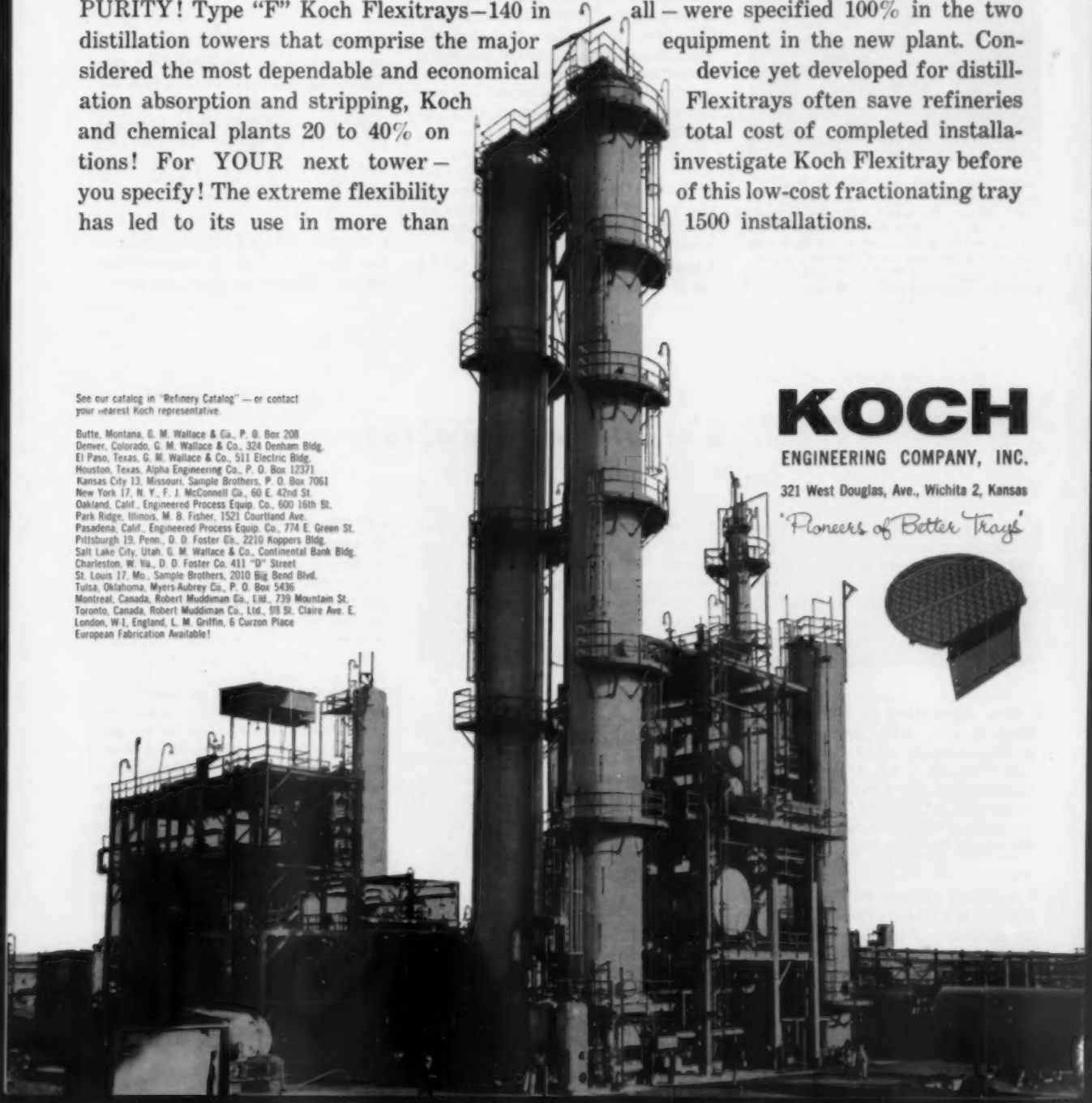
IN LARGEST U. S. PROPYLENE PLANT

SUN OIL COMPANY'S $2,000,000 PROPYLENE PLANT – recently placed in successful operation at Sun's huge Marcus Hook, Pennsylvania, refinery – has a potential capacity of 120,000,000 pounds of high-purity propylene per year. Reputedly the largest operation of its kind in the United States, designed to produce the high-purity propylene required by manufacturers of polypropylene – Sun's new plant is currently producing a material with 99.9% purity from refinery gas streams. KOCH FLEXITRAYS HELP MAINTAIN THAT PURITY! Type "F" Koch Flexitrays—140 in all – were specified 100% in the two distillation towers that comprise the major equipment in the new plant. Considered the most dependable and economical device yet developed for distillation absorption and stripping, Koch Flexitrays often save refineries and chemical plants 20 to 40% on total cost of completed installations! For YOUR next tower – investigate Koch Flexitray you specify! The extreme flexibility of this low-cost fractionating tray has led to its use in more than 1500 installations.



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construction briefs...

Slowly being lifted into position is a new deisobutanizer tower at Gulf's Port Arthur, Texas, refinery. The vessel, suspended between two gin poles, represents the largest single lift ever made at the plant and undoubtedly one of the heaviest in oil industry history. Tower measures 196 ft, 4 in. in length, 20 ft across the base, and weighs 195 tons.

Sunray Oil Co. will build a new crude oil distillation unit with capacity of 85,000 bbl a day at its Tulsa, Oklahoma, refinery. New unit will replace five crude units currently in operation which will be dismantled or used for other processing. These have a combined capacity of 75,000 bbl per day.

Waste heat recovery plant being built at the Whiting refinery of Standard Oil Co. (Indiana) will save fuel equal to the average yearly fuel consumption by more than 16,000 homes. The new unit is being added to a revamped and expanded fluid catalytic cracking plant which makes gasoline.

Florida Oil and Refining Co. will build a $15,000,000 refinery at Jacksonville, Florida, near a terminal now under construction for Gulf Oil Corp. Crude will be supplied by U. S. Oil of Louisiana.

Badger Manufacturing Co. has begun work on a new 32,000 bbl per day vacuum distillation unit for Ashland Oil and Refining Co. at Catlettsburg, Kentucky.

Skelly Oil Co. will construct a gasoline plant near Minneola, Kansas, to produce about 15,000 gal per day.

Bechtel Corp., San Francisco, was successful bidder for Gulf Oil's new lubricating oil facilities at the Port Arthur, Texas, refinery. Designed as twin units, the 13,000 bbl per day operation will handle a dozen different feed streams. Process will carry the trade name "Gulfinishing."

Frontier Refining's Beeline plant in Salt Lake City will be enlarged from 5500 to 7500 bbl per day capacity.

...petroleum chemicals

Three multi-million dollar contracts for design and construction of olefin and polyolefin plants in Odessa, Texas, have been awarded to Fluor Corp., Universal Oil Products, and Fish Engineering Corp. The plants are a joint venture of Rexall Chemical Company and El Paso Natural Gas Products.

First application of Universal Oil Products Co.'s Alkar process will be in the expansion of El Paso Natural Gas Products Co.'s Odessa, Texas, styrene plant. Plant, now operating at capacity of 60,000,000 lb a year, will be enlarged to annual capacity of 80,000,000 lb by early fall.

Firestone Plastics Co. has awarded contract to Catalytic Construction Co. for expansion of its polyvinyl chloride resins plant at Pottstown, Pennsylvania, expected to be in operation by early 1961.

Catalytic Construction Co. has contract for engineering, procurement, and construction of an alkyl alkanol amines plant at the Wyandotte, Michigan, works of Pennsalt Chemicals Corp. The facility, estimated to cost $1,500,000, is scheduled for completion in late 1960.

Stauffer Chemical Co. will build a captive chlorine plant in the Wilmington area of Los Angeles. Total output will be supplied to American Chemical Corporation (jointly owned by Stauffer and Richfield Oil Co.) as a raw material for the manufacture of vinyl chloride, ethylene chloride, and ethylene dichloride.

A styrene unit to produce 60,000,000 lb annually will be built at the Suntide Refining Co. plant in Corpus Christi, Texas.

Phillips Chemical Co. has upped production capacity of its new Cis-4 polybutadiene rubber plant at Borger, Texas, by 5000 long tons a year. The expansion is an addition to the 20,000-tons a year plant now being constructed.

Celanese Corporation of America has announced plans for a major expansion at its Pampa, Texas, plant for the production of higher acrylate esters. Plant's overall capacity will have been doubled when the expansion is completed before the end of 1960.

One of the nation's largest chemical fertilizer plants will be built at Fort Madison, Iowa, by California Spray-Chemical Corporation, a subsidiary of California Chemical Company. The $22,000,000 plant will be capable of producing more than 1000 tons daily of a wide variety of chemical fertilizers.

. . . international scene

▸ **M. W. Kellogg Co.** has been awarded the engineering and construction contract for Sun Oil Co.'s $8,000,000 naphthalene plant at the Toledo, Ohio, refinery. The facility, with capacity of 100,000,000 lb per year, will be the world's largest petroleum naphthalene plant.

▸ **Allied Chemical** will build a plant in Elizabeth, New Jersey, to make refrigerants and aerosol propellants. Estimated cost is in excess of $1,000,000.

▸ **Capacity of Enjay Chemical's** Baytown, Texas, orthoxylene plant will be increased from 44,000,000 to 72,000,000 lb per year by the end of 1960.

▸ **Badger Manufacturing Co.** has contract for engineering, procurement, and construction of a Udex aromatics extraction unit and orthoxylene recovery and purification facilities for Cities Service at Lake Charles, Louisiana. Plant will be the largest ever built specifically for orthoxylene production, with stated annual capacity of 120,000,000 lb per year.

▸ **Shell Chemical** will expand its styrene production facilities at Torrance, California, to raise plant capacity to 210,000,000 lb a year by early 1961.

▸ **AviSun,** joint venture of Sun Oil and American Viscose, will build a 100,000,000 lb per year polypropylene resin plant at New Castle, Delaware. Bechtel Corp. will handle engineering.

▸ **American Rubber and Chemical Co.** a joint venture of Stauffer Chemical Co., New York, and American Synthetic Rubber Co., Louisville, Kentucky, will build a multi-million dollar plant at Louisville to produce polybutadiene and polyisoprene synthetic rubbers. The new company has obtained a license for processes to be used from Phillips Petroleum Co.

▸ **Allied Chemical Corp.** will construct a plant at Baton Rouge, Louisiana, to make 20,000,000 lb a year of polyethers used in both flexible and rigid urethane foams. Plant is expected to be in operation by mid-1961.

▸ **Sid Richardson Carbon** will use United Carbon's processes for oil furnace carbon blacks at a 50,000,000 lb per year plant to be built adjoining Cosden Petroleum's Big Spring, Texas refinery.

▸ **India's first synthetic rubber manufacturing plant,** near Bareilly, Uttar Pradesh, will be designed and constructed by Lummus Co., Ltd., London. Lummus will direct the $30,000,000 project for Synthetics and Chemicals, Ltd., a company formed recently by Firestone Tire & Rubber Co. with Kilechand Devchand and Co. Private Ltd., a Bombay banking and industrial firm. Plant will produce butadiene and styrene as well as the final product.

▸ **Scientific Design Company, Inc.,** will design and construct a 10,500,000 lb per year maleic anhydride plant at Niort, Deux-Sevres, France, for Societe Anonyme Reichhold Beckacite, France, an affiliate of Reichhold Chemicals, Inc., White Plains, New York, and will grant a license for the use of the SD maleic anhydride process and the special catalyst required.

▸ **Colombia's first polyvinyl chloride plant** will be built near Bogota by B. F. Goodrich Chemical Co. in cooperation with Colombian participants.

Esso Nederland's $50,000,000 Rotterdam refinery is now onstream, producing 100,000 bbl per std day. Badger N.V., Dutch affiliate of Badger Manufacturing Co., was prime contractor.

▸ **Maruzen Oil and Dow Chemical International** will construct a $44,000,000 phenol plant to produce 10,000 tons per year at Matsuyama, Japan.

▸ **A $4,200,000 plant at Kawasaki, Japan,** to produce 15,000 tons per year of alkyl benzene, will be built by Oronite Chemical and Japan Petrochemical.

▸ **Suedenpetrol AG,** Munich, Germany, subsidiary of the Italian Government-controlled ENI, will build a refinery on the Danube at Ingolstadt, terminus for the projected Genoa-Bavaria pipeline.

▸ **A 12,000 bbl per day, $15,000,000 refinery** will be constructed at Conchan Beach, about 15 miles south of Lima, Peru. Standard Oil Company of California will supervise construction.

▸ **A new Salvadorean associate** of the Royal Dutch/Shell Group will construct a 10,000 bbl a day refinery at Acajutla to serve El Salvador, Honduras, Nicaragua, and Costa Rica.

▸ **Deutsche Shell's new** 50,000 bbl per day refinery at Godorf, near Cologne, Germany, will be expanded to 80,000 bbl per day capacity by 1965.

▸ **Iraq's** General Board of Oil Affairs will build a 40,000 bbl per day, $56,000,000 refinery at Basra.

▸ **Celulosa y Derivados, SA,** will build plants at Monterrey, Mexico, to produce hydrofluoric acid, carbon tetrachloride, and fluorinated hydrocarbons. General Chemical division, Allied Chemical Corp., will provide technical data for the project.

▸ **Hydrocarbon Research, Inc.,** New York, has contract to engineer and construct expansion of the catalytic and related facilities of the refinery near Lisbon, Portugal, owned by SACOR (Sociedade Anonima Concessionaria da Refinagao de Petroleos en Portugal).

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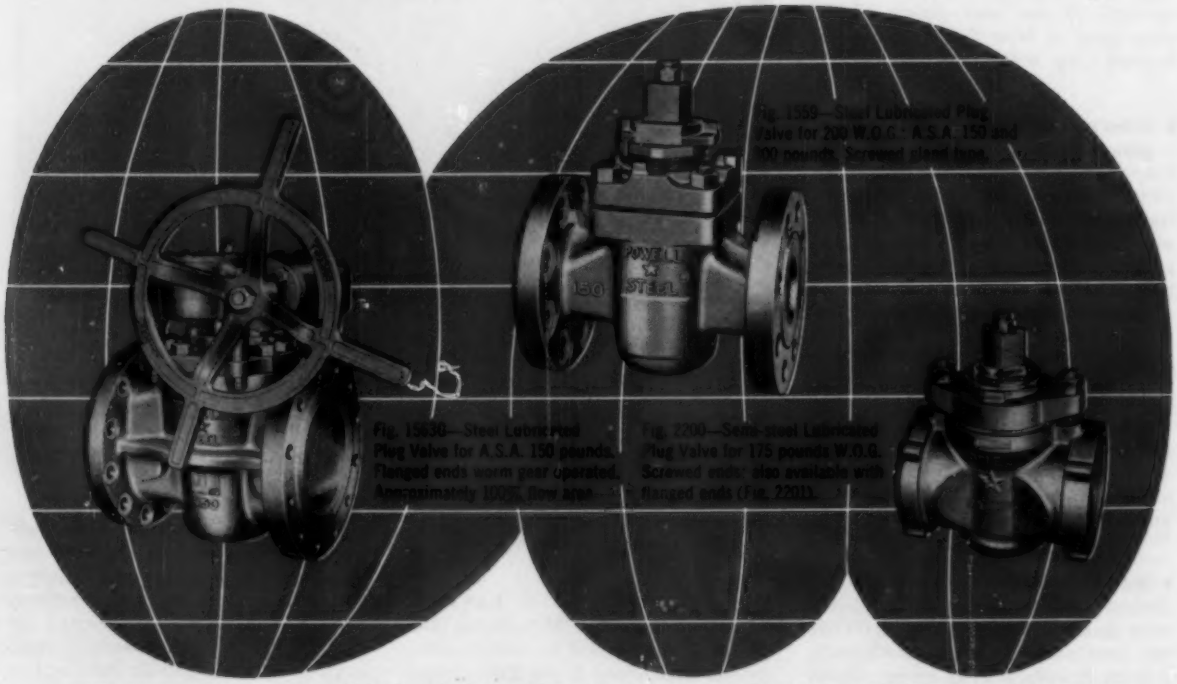

Fig. 1569—Steel Lubricated Plug Valve for 200 W.O.G., A.S.A. 150 and 300 pounds. Screwed gland type.

Fig. 1563G—Steel Lubricated Plug Valve for A.S.A. 150 pounds. Flanged ends worm gear operated. Approximately 100% flow area.

Fig. 2200—Semi-steel Lubricated Plug Valve for 175 pounds W.O.G. Screwed ends; also available with flanged ends (Fig. 2201).

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7074 computer

Advanced solid-state IBM 7074 computer can process business data twice as fast and do scientific computation 20 times as fast as the 7070 system to which it is related. A 7070 can be converted to a 7074 system in the customer's office. The major change is replacement of the three 7070 modules with two high-speed 7074 components. *International Business Machines Corporation.*

Circle number (41) on reply card.

Chromatographic gas analyzer

Gasofract Model 300 is a universal instrument for analyses of gases and liquids by adsorption and partition chromatography. Fractionation unit, equipped with an air thermostat, operates at temperatures ranging from 25 to 300 C. The recording unit, optionally equipped with an electronic or electromechanic integrator, makes possible recording of the TC curves, their integrals, or both in one operation. *Dr. Virus KG.*

Circle number (42) on reply card.

Low-cost fuel oil additive

UOP's new Polyflo 120 provides effective stabilization of fuel oil at lower cost . . . is especially suitable for treatment of No. 2 heating oil and diesel fuel derived from a wide range of crude stocks . . . can be applied to other distillates. Polyflo 120 will maintain fuel oil stability throughout seasonal storage periods even under high summer heat conditions. Water white, it is highly effective as a color stabilizer, sediment inhibitor, and anti-emulsion agent. Can be added to distillate stocks before, during, or after blending at the refinery. *Universal Oil Products Company.*

Circle number (43) on reply card.

Fiberglass flake protective coating

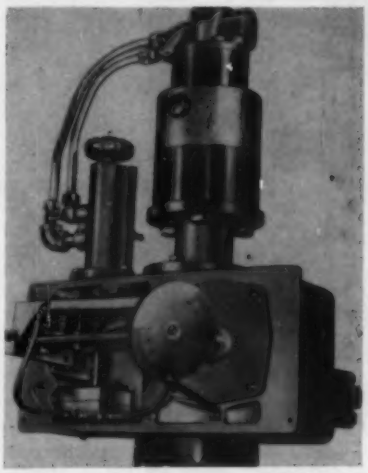
New spray coating providing a corrosion-resistant surface to metals, wood and concrete, is now available in sample quantities, along with a spray gun unit especially designed for applying the product. Accelerated weathering tests have shown virtually no deterioration, and laboratory tests of the coating show vapor transmission of less than .01 perms; shear strength of 800 psi, and dielectric strength of 500 v per mil. *Owens-Corning Fiberglas Corporation.*

Circle number (44) on reply card.

High density plastic pipe

Poly III high-density plastic pipe is now available along with polypropylene resin fittings. Pipe comes in sizes of ½-in. through 2-in. . . . has 50-year life expectancy. *Crane Co.*

Circle number (45) on reply card.



Pneumatic pump controller

Pneumatic controller makes metering of fluids in process work entirely automatic. Requiring only 21 in. headroom, it bolts onto any run-adjust model of W&T Series 200, 400, or 600 pump in place of the normal adjusting handle. Controller will automatically adjust the pump's stroke length to give varying rates of flow of the metered liquid. *Wallace & Tiernan Incorporated.*

Circle number (46) on reply card.

Fumaric acid process

New and simple fumaric acid process offers excellent commercial possibilities for recovering fumaric values from almost any maleic containing feedstock. Can also be used for straight fumaric acid production from prime feedstocks. Process employs a special catalyst and is based on moderate isomerization conditions. Maleic containing feedstocks that can be upgraded include maleic scrubber solution, phthalic scrubber solution, and maleic refiner bottoms. Prime feedstocks include benzene and butenes. *Scientific Design Company, Inc.*

Circle number (47) on reply card.

Safety-relief valves

Farris 1870 valve series provides precise blowdown ring control for gases and vapors and safety relief for liquids in a wide range of applications where maximum pressure is 300 psi. Has 1-piece stainless steel body. Stainless steel disc contain inlet pressure without other joints or gasketing. Leak-proof seat eliminates waste and corrosion problems. Available with tungsten steel springs for temperatures up to 800 F. Conforms to ASME Power Boiler Code (Section 1) and ASME Unfired Pressure Boiler Code (Section 8). *Farris Engineering Corporation.*

Circle number (48) on reply card.

Hydraulic acoustic filter

The PULSCO acoustic filter reduces liquid borne noises in hydraulic systems, water systems, and electronic cooling systems, removing as much as 99% of the noise energy. Units are applicable both to high pressure hydraulic systems to remove noises from positive displacement pumps and to water systems to eliminate noises caused by centrifugal and turbine type pumps. *Pulsation Controls Corporation.*

Circle number (49) on reply card.

Low-cost electric counter

Tally-Count 242, a fully electronic predetermining counter, is capable of batching qualities up to 100 . . . actuates equipment at speeds faster than 1000 operations a minute. Applications include batch counting, linear measurement and cut-off, container filling, sheet counting, and machine cycling. *Standard Instrument Corporation.*

Circle number (50) on reply card.

Compact cylinder operated valves

Compactly designed cylinder-operated valves can be clustered in remote or restricted spaces. Cylinders have been changed from pivot to nose mount, eliminating the bulky pivot beam. Unit can be installed in any position for automatic sequence or multiple valve operation. *Everlasting Valve Company.*

Circle number (51) on reply card.

Improved portable X-ray unit

Baltograph 300 portable X-ray unit now is available with a 360-deg X-ray tube which allows circumferential radiography as well as single beam use. Original model, offering conventional single beam operation, is still available. Net carrying weight has been reduced by 14 lb to 136. *Balteau Electric Corp.*

Circle number (52) on reply card.

Miniature strain gage accelerometer

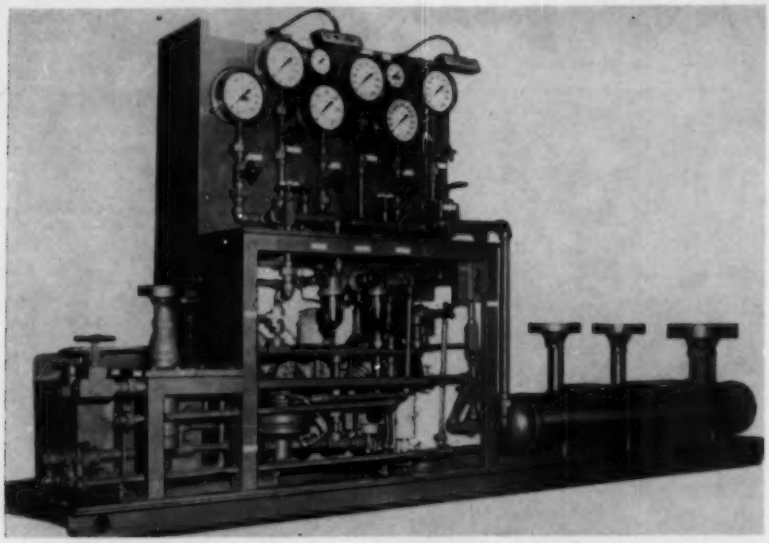
Type 4-202 is said to be smallest temperature compensated strain gage accelerometer now available. Is a linear unbonded bi-directional instrument designed for measuring accelerations perpendicular to the mounting surface. Unit weighs less

than three ounces and is one cu in. in size. Its linearity and hysteresis qualities are conservatively rated at less than ±0.75% of full range output. Standard ranges are from ±5 to ±500g. *Consolidated Electrodynamics Corporation.*

Circle number (53) on reply card.

(Continued on C-60)

Equipment *(Continued)*



Programmed-temperature gas chromatograph

Programmed-temperature gas chromatograph permits column operation from ambient to 500 C. High stability is achieved by using a reference column as well as a sample column, which are identical and are symmetrically heated by a vertical heating plate. Instrument permits symmetrical backflushing so that history of both the reference and sample columns remains the same. *Loe Engineering Company.*

Circle number (54) on reply card.

High temperature chempump

New sealless "canned" pump for high temperature operation features an externally-mounted heat exchanger, plus water cooling jackets around the motor section for maximum cooling. Pump and motor are one unit, and a portion of the pumped fluid circulates through the motor section between the rotor and stator, both of which are "canned" in corrosion-proof, non-magnetic liners. *Chempump Division, Fostoria Corporation.*

Circle number (55) on reply card.

Portable TV camera works in dim light

Dage Model 81 Industrial 10 Camera, a small lightweight portable unit, solves problem of television monitoring at light levels which render Vidicon cameras useless. It uses an Image Orthicon camera

tube with completely transistorized circuits, thus breaking the weight barrier and providing a camera that will operate remotely from the camera control. *Dage Television Division, Thompson Ramo Wooldridge Inc.*

Circle number (56) on reply card.

Furane plastic pipe

Eonite reinforced furane plastic pipe is particularly suited for use in process and transfer of acids, alkalis, and solvents. The chemical-resistant pipe is strong, dimensionally stable, and can carry—without distortion or deterioration—hot corrosive liquids and gases at temperatures up to 300 F at pressures up to 150 psig. It permits increased flow rates to as much as 20 percent greater than steel pipe of the same size. Available in 15-ft lengths in seven sizes with wall thicknesses from 5/16 to 9/16-in., and from 2 to 12-in. ID. *Cornelius A. Rauh & Associates, Inc.*

Circle number (57) on reply card.

High temperature heat transfer cement

Thermon T-63, high temperature heat transfer cement, is an inorganic, nontoxic, inert material that is easily applied on process lines, vessels, pumps, metals, and plastic dies, and other production and process equipment. Designed for use in temperature ranges from 600 to 1250 F. Will increase heater efficiency, lower heater sheath temperatures, give uniform heating, and reduce power and maintenance costs. *Thermon Manufacturing Company.*

Circle number (58) on reply card.

Phthalic anhydride catalyst

New universal catalyst permits the phthalic anhydride producer using a fixed bed process to utilize either napthalene or ortho-xylene at high yield, and also mixtures of naphthalene and ortho-xylene, depending upon their availability and price. *Scientific Design Company, Inc.*

Circle number (59) on reply card.

2-wire control system

Varelectric, new 2-wire supervisory control system, provides instantaneous control of pump motors, valve operators, and similar equipment. It uses only one wire between each control and field unit, plus one conductor common to many units. *Vapor Recovery Systems Co.*

Circle number (60) on reply card.

Universal test stand

♦ New unit will test all valves including globe, gate, plug cocks, safety, and relief plus other hydraulic-pneumatic equipment. Built-in compressor provides useful source of compressed air for general plant service. Compact (10½ by 3 ft) and easy to operate, yet wide range permits testing of pressure settings up to 2000 psi for air and 6000 psi for water. *Farris Engineering Corporation.*

Circle number (61) on reply card.

Automatic measuring pump

MFC-250 metered flow control pump will transfer and measure materials of widely varying viscosities and physical characteristics with accuracy of within 0.5 percent. Available in two models . . . gearhead with cycle monitor or varidrive with tachometer. *Waukesha Foundry Company.*

Circle number (62) on reply card.

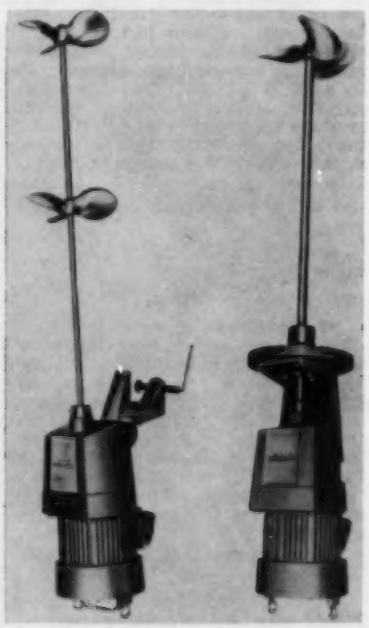
Servomatic transducer

Transcope 710T Servomatic Transducer converts a pneumatic input to an electrical output, making possible utilization of electronic data loggers and computers with pneumatic transmitters. Instrument consists of a pneumatic servo motor which cable drives a potentiometer mounted on a common bracket. *Taylor Instrument Companies.*

Circle number (63) on reply card.

Portable mixers

"Lightnin" propeller-type portable mixers for fluid agitation in process industries are available in sizes ranging from ⅛ to 3 hp and in a fixed mounting design in all except the ⅛-hp size. Direct drive models have speeds of 1750 and



1150 rpm. Gear drive models have speeds of 350 rpm. Positive drive chuck permits fast, accurate coupling in one simple operation. *Mixing Equipment Co., Inc.*

Circle number (64) on reply card.

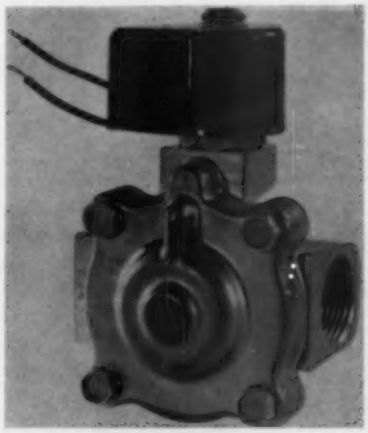
Non-slip floor coating

Abrasive Overlay floor coating eliminates danger of accidents caused by employees slipping on slick floors. A heavy-bodied plastic compound with a wear resisting mineral-type aggregate, it is designed for troweling over metal, wood, concrete, or mastic to form a non-slip coating. Is highly resistant to water, gasoline, oil, alcohol, and many acids. *Paramount Industrial Products Co.*

Circle number (65) on reply card.

2-way solenoid valve

New 2-way, general purpose solenoid valve has 1-in. pipe connections and just three operating parts. Has forged brass body and bonnet. Handles, air, gas, water,



light oil, and other non-corrosive liquids or gases at pressures from 5 to 125 psi. *Automatic Switch Company.*

Circle number (66) on reply card.

New discs for loading valves

Discs of Neoprene, Compar, Silicone, Teflon, and Viton-A are now available in in addition to the standard Buna-N disc usually furnished with No. 417 and 418 loading valves. By replacing the Buna-N disc with one of the new discs, a standard loading valve can be adapted to many other fluids. *OPW-Jordan Corporation.*

Circle number (67) on reply card.

Peak-picking recorder

Peak-picking recorder is being used in conjunction with gas chromatography equipment to increase versatility of a trend recording analyzer system for close control of process streams. The industrial gas chromatograph analyzes each component of interest in the process stream and electrically measures the quantity of each such substance present. A timing device permits analysis at required intervals. *Weston Instruments Division, Daystrom Incorporated.*

Circle number (68) on reply card.

Pneumatic controllers

A/D Model 624 Pneumatic Controllers feature simple modular design for ease of servicing and high control stability for closer process control. They are available in models for proportional, reset, pressure, temperature, flow and differential pressure, humidity, and differential liquid level control. *The Bristol Company.*

Circle number (69) on reply card.

Descaler dissolves scale without corroding metal

Scale-Cleen, new safe, easy-to-use descaler, is made with sulfamic acid and inhibitors that allow the acid to clean and dissolve scale without corroding or damaging metal. Product has no irritating fumes and will not harm skin. Built-in color indicator shows when acid has been spent. *Dearborn Chemical Company.*

Circle number (70) on reply card.

Impervite diaphragm valves

New series of small diameter impervious graphite diaphragm valves features high Cv factor. Valves are unaffected by most corrosives, immune to effects of thermal shock, are non-contaminating, accommodate operating pressures to 50 psi at temperatures to 340 F, and can handle gas, liquids, or sluries. Bonnet is independently removable. Available in seven sizes to 8-in. in diam. Larger diameters can be steel encased where required. *Falls Industries, Inc.*

Circle number (71) on reply card.

High pressure thermal wells

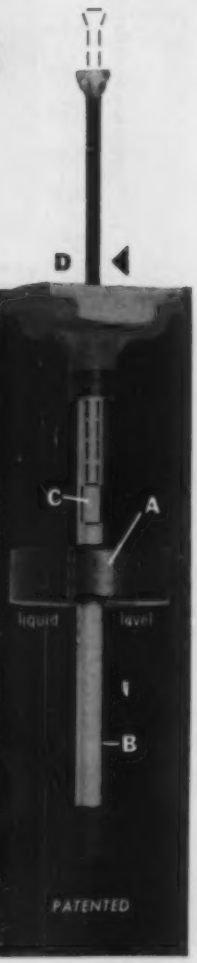
Pressures up to 3000 psi at 600 F or 2000 psi at 700 F can be handled by new thermal wells which are available in 3 styles — coupling head, hex head, and with a moisture-sealed, tamper-proof cover. All are Type 316 stainless steel with heliarc welded junctions. *Fenwal Incorporated.*

Circle number (72) on reply card.

(Continued on C-64)

Now*... measure levels of any liquid in any container with this hermetically sealed "dripless dripstick"

Mounts Top or Bottom

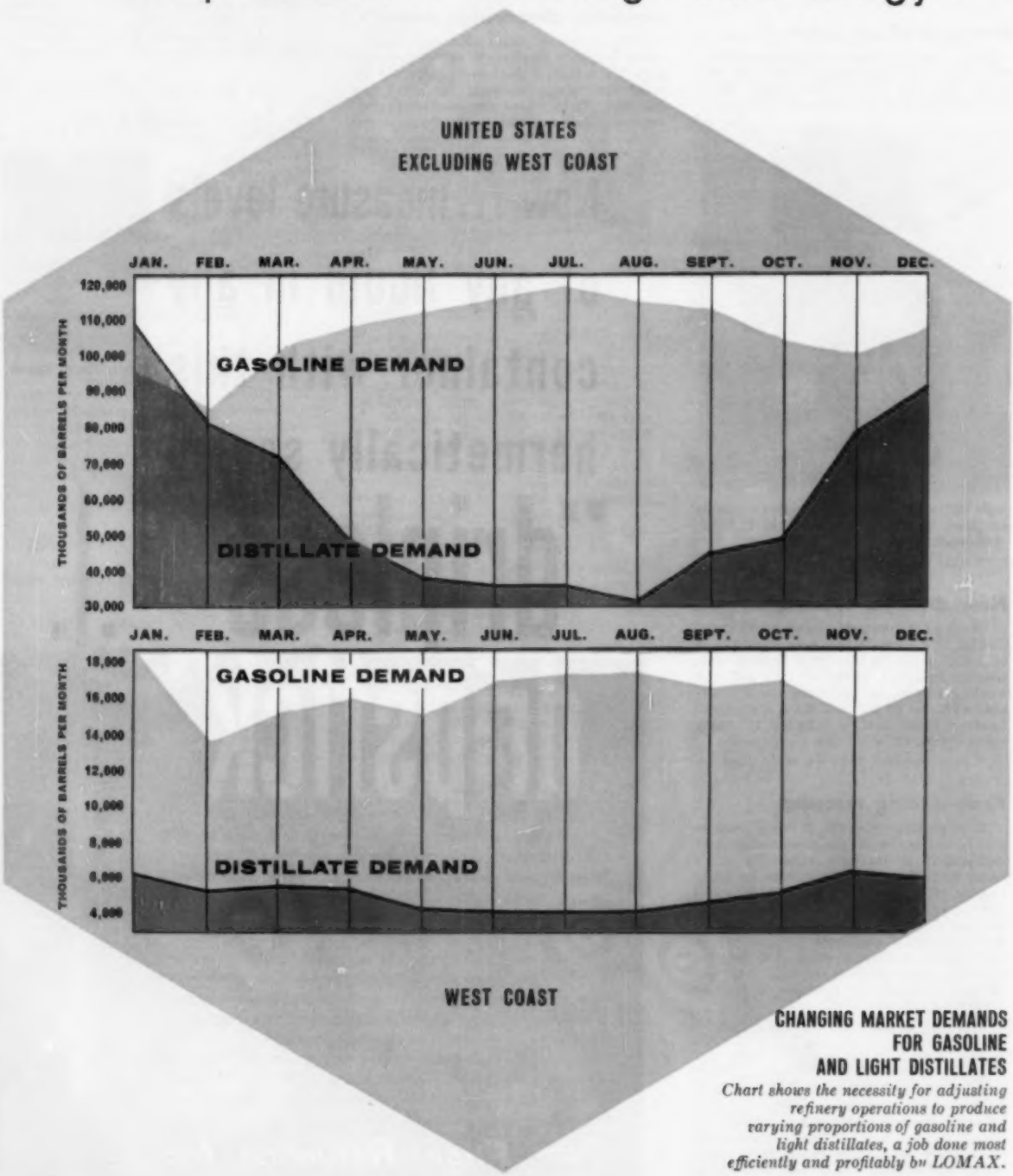


From table oils to toxic chemicals, the FRI "dripless dripstick" can accurately measure the contents of any container. Throughout the petroleum and chemical industry, wherever liquid levels must be determined, this easy-to-read indicator can do the job faster, safer, and with absolutely no contact of the indicator rod with the liquid to be measured. How does it work? A doughnut shaped magnetized float (A) surrounds a guide tube (B) and rides the level of the liquid. A calibrated rod with a magnetic tip (C) is pulled out until magnets A and C engage. Then, the liquid level is read at point D outside the container. Request specifications and prices on your letterhead. **Fully Tested in Use*

Flight Refueling, Inc.
COMMERCIAL PRODUCTS SECTION
BOX 1701 · BALTIMORE 3, MARYLAND

PATENTED

now...**a major breakthrough** in petroleum refining technology...



CHANGING MARKET DEMANDS FOR GASOLINE AND LIGHT DISTILLATES

Chart shows the necessity for adjusting refinery operations to produce varying proportions of gasoline and light distillates, a job done most efficiently and profitably by LOMAX.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

LOMAX

TRADEMARK

the versatile **new UOP** process

Here is a new and vastly important process to which every refiner should give serious consideration—now! Regardless of present markets and whether existing facilities are old or up-to-the-minute, LOMAX may prove economically attractive through *increased year-'round production of your most saleable products.*

Through the reaction of oil with hydrogen in the presence of a new UOP catalyst, LOMAX converts middle distillates, ranging from kerosines to heavy gas oils, into a wide ratio of gasoline or distillate fuels. This highly flexible process may be used to supplement existing facilities, or as a basic cracking operation in a new installation.

Advantages offered by LOMAX also include: Predominance of branched isomers in light hydrocarbons . . . greatly reduced quantities of light gases . . . olefin-free products . . . no catalyst deposit . . . distillates of exceptional high purity (even from sour crudes) . . . and other important benefits.

- **LOMAX** produces **maximum saleable product**...up to 120 barrels of product from 100 barrels of charge stock.

- **LOMAX** gives you **maximum production** of the product you want when you want it...whether gasoline or light distillates.

UOP

Write for detailed technical information. Address:

UNIVERSAL OIL PRODUCTS COMPANY

30 Algonquin Road, Des Plaines, Illinois, U.S.A.

WHERE RESEARCH TODAY
MEANS PROGRESS TOMORROW

Facts-of-Life for successful engineers must include attitude, self-appraisal, vision, understanding, respect, relaxation and "happiness"

Achieving "success" and/or "happiness" in your professional and personal future won't just "happen," regardless of how diligently you apply yourself to your daily tasks, unless your efforts are coordinated along specific paths of endeavor. Your life as an engineer must be counterbalanced by your life as an individual — because "engineers ARE human," despite comment to the contrary.

The engineer reacts to the same human stimuli and motivations as the man in the accounting division, the sales department, the repair and maintenance crew, the general office force, or in the management division. All are motivated to varying extents by the same drives for recognition, self-respect, material progress, functional importance, personal pleasure, financial stability — and "security," however, the latter is translated.

The fact of the matter is no longer "theoretical," it is accepted, proven, practical "common-sense": to accomplish either or both of these achievements, your pursuit of "happiness" and/or "success" must have (a) ambition, (b) definition, (c) purpose, (d) direction. It is a life-long pursuit, subject to many detours and changes. In the pursuit itself, however, will be found much of its own reward.

One of our basic problems seems to stem from our relationships with *others* — our reactions to the drives of other people and their reactions to ours, because, like it or not, we *are* affected by other people, and they are affected by us.

Professionally, we are affected by our superiors, associates and subordinates — both technical and non-technical. Personally, we are affected by our family, our relatives and our friends — on and off the job. Our object then, is to ascribe to both our professional and personal life those qualities and human attributes which bring professional success and personal happiness. *We must develop a formula for living.*

This limited space, of course, does not permit a full look at this most complex of subjects, but a more complete treatment of human relations in engineering is found in a booklet entitled "Success and/or Happiness — in Engineering," available free upon request. Write for your copy to WESTERN SUPPLY COMPANY, HEAT EXCHANGER DIVISION, P. O. BOX 1888, TULSA, OKLA. — and remember, *our* success and happiness stems partially from the heat exchangers in *your* future.

Equipment (Continued)

Tantalum shielded gaskets

Tantalum shielded gaskets have been developed for use in highly corrosive environments at temperatures to 700 F and pressures to 1000 psi where Teflon shielded gaskets would not be acceptable. They fit standard nozzle and manhole openings from 1 to 36 in. *The Pfaudler Co.*

Circle number (73) on reply card.

Automatic valve lubricator

Automatic valve lubricator provides lubricated plug valves with a continuous and regulated supply of lubricant. Unit is particularly applicable for remote valve installations where controlled and automatic lubrication is a necessity. Since it can be set to furnish lubricant only when the valve requires it, there is no waste. *Rockwell Manufacturing Company.*

Circle number (74) on reply card.

Air cylinder mounts

Three new mounts — angle bracket, side leg, and extended tie rod — have been added to mountings available for line of square-end double-acting air cylinders. The basic cylinder can now be employed with 8 interchangeable mountings, making a large inventory of specialized cylinders unnecessary. *A. Schrader's Son.*

Circle number (75) on reply card.

Electrical vacuum gage

Model SP-3 vacuum gage covers range of 10 to 200 mm HG absolute . . . offers accurate, direct reading pressure measurements unaffected by atmospheric pressure changes or exposure. Particularly well-suited to remote installations, the units are available in cabinet, panel, control, and recorder type instruments. *Hastings-Raydist Incorporated.*

Circle number (76) on reply card.

2-channel time recorder

Two-channel time recorder graphs simultaneously, on a single strip chart, the operating patterns of two machines, two functions of the same machine, or any two processes. May be connected to distinguish between actual productive time

and non-productive idling time. Unique feature is a read-out counter, which continuously furnishes a visual sum of productive time in hours and tenths or minutes and tenths. *Standard Instrument Corporation.*

Circle number (77) on reply card.

Armored purge meters

New line of armored purge meters are designed to withstand pressures to 1500 psi and temperatures to 400 F. Have water capacity from 1.6 to 100 gal per hr, and air capacity of 7.5 to 420 std cu ft per hr. All piping connections have ½-in. NPT threads, regardless of meter capacity. *Wallace & Tiernan Incorporated.*

Circle number (78) on reply card.

Automatic lubrication system for compressor, cylinders

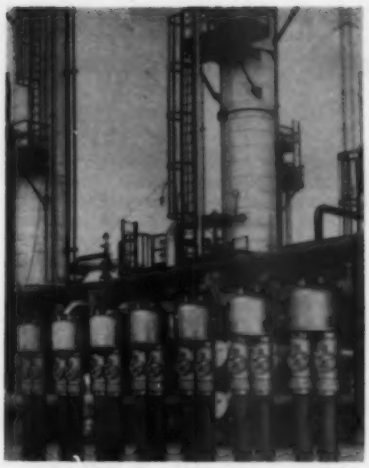
Highly compact automatic system delivers lubricant in precise amounts consistently and at prescribed intervals to compressor and power cylinders. Features include pneumatic safety control, positive proof of oil delivery to cylinders, simplified cycling control, and the ability to handle synthetic oils. *Meter-Pak.*

Circle number (79) on reply card.

Pre-packaged test materials aid in detecting cracks

Magnaflux and Magnaglo materials for use in detecting cracks during construction or maintenance overhaul are now available in pressurized spray cans and plastic squeeze-bottles. They can be used with any of the magnetic particle inspection equipment or test kits already in operation. *Magnaflux Corporation.*

Circle number (80) on reply card.



Above ground manhole condulets

Type EAM explosion-proof, dust-ignition-proof, and weather resistant above ground manhole condulet provides convenient means for splicing main feeder cable and making branch taps. They replace the conventional expensive below ground man holes, which are often difficult to work in due to gas contamination or the accumulation of water. Suitable for voltages up to 600. *Crouse-Hinds Company.*

Circle number (121) on reply card.

Pump for liquid proportioning systems

New Vari-Flo pump is being used to build simplified, low-cost systems for proportioning liquids. Unit is a vane-type positive displacement pump with a unique flow-changing device that varies the pump capacity from zero to full flow while the pump operates at constant speed. *Blackmer Pump Company.*

Circle number (122) on reply card.

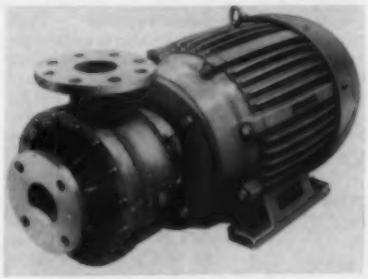
Split bus load center

New 200-amp split bus "Twin" load center has space for six 2-pole breakers in the main section, three of which serve as sub-section mains, and accommodates up to 28 single-pole circuits with 1-in. TQL breakers or 30 circuits with 2-in-1 "Twin" breakers. The single-phase, 3-wire device is suitable for use with 2-pole, plug-in Type TQL and TQAL circuit breakers rated up to 100 amp. *General Electric Company.*

Circle number (123) on reply card.

Aluminum alloy centrifugal pumps

Group of all aluminum alloy centrifugal pumps rated at capacities from 5 to 3000 gal per min, with heads to 550 ft, are designed for use in processes where ferrous contamination and/or light weight



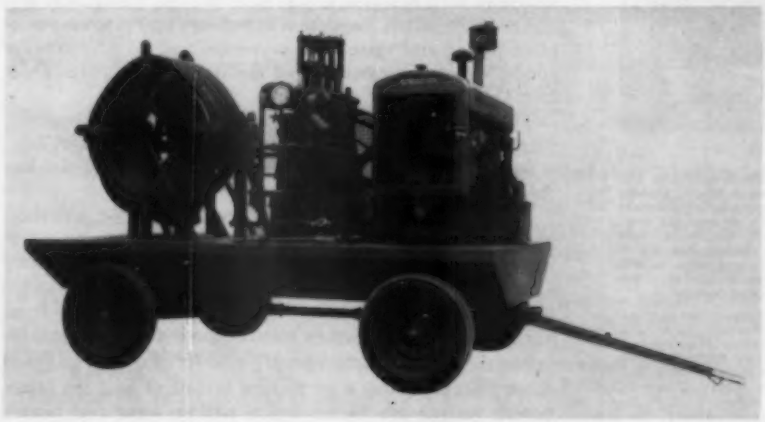
are important considerations. Pumps are up to 70% lighter in weight than comparable stainless steel models. *J. C. Carter Company.*

Circle number (124) on reply card.

Temperature control valve

Air-operated sliding gate temperature control valve, with capacities to 50,000 lb of steam per hour or 2500 gal per min of water, is now available in 4 and 6-in. sizes. Used for heating or cooling service, wherever large capacities, accurate control, and tight shut-off are required. *OPW-Jordan Corporation.*

Circle number (125) on reply card.



Hydraulic cleaning units

Portable HYJET unit utilizes a jet stream of water up to 4000 psig or higher through a high pressure nozzle for hydraulic cleaning of heat exchanger tube bundles and other cleaning and descaling operations. No cleaning solutions or solvents are necessary. Wide range of pressures and capacities is offered. *Power Specialty Company.*

Circle number (126) on reply card.

For Speediest Repair of Corrosion Leaks in Pipe

JUNIOR

EMERGENCY PIPE CLAMP

Repair pipe leaks QUICKLY!

Speediest application — slotted lug permits the single plated bolt to slide instantly into place.

A companion to the old reliable Emergency Pipe Clamp that has served industry for a half century, the JUNIOR, a single bolt clamp, is 2⅞" wide. Undersells most band-type clamps.

Made of malleable iron, ruggedly proportioned, with full-length hinge along one side. Formed to exact pipe size—no bending. The recessed pressure-equalizing gasket, entire width of clamp, is cemented in. A lasting installation. 2" pipe size—$1.80; 2½"—$2.20; 3"—$2.30. Write for new circular on the Junior.

SKINNER-SEAL

EMERGENCY PIPE CLAMPS for safe, sure lasting repair of splits and rust holes in pipe. No pressure too high. Anyone can apply in a few moments. Made in all sizes, ½" to 12", for steel and C. I. pipe. Stocked by practically all oil supply stores.

Send for catalog!

M. B. SKINNER CO.

SOUTH BEND 21, INDIANA

PETRO/CHEM new literature

Air control valve catalog . . . 40 pages . . . covers inline 2, 3, and 4-way valves and sub-base mounted 4-way and 4-way, 5-port valves. Gives information on installation and maintenance, and on conversion of valves to external pilot supply. *Hoffman-Odom Company.*

Circle number (126) on reply card.

Chemical Market Abstracts . . . How this monthly publication can be used is explained in new booklet. *Foster D. Snell, Inc.*

Circle number (127) on reply card.

Cooling tower life . . . can be extended by following suggestions in new water conditioning data sheet which tells how to prevent deterioration of wood. *Betz Laboratories, Inc.*

Circle number (128) on reply card.

Engineering services . . . of Dorr-Oliver Inc., Stamford, Connecticut, are described in Bulletin 8010. *Dorr-Oliver Inc.*

Circle number (129) on reply card.

General catalog for the process industries . . . gives information on railroad cars, custom fabrication, field erection, storage terminals, mixing devices, driers, and other products and services. *General American Transportation Corporation.*

Circle number (130) on reply card.

Gyro-integrating mass flowmeter . . . is detailed in Bulletin GEZ-3025, which gives ratings, typical applications. Included is discussion of benefits of converting from volumetric to mass flow measurement. *General Electric Company.*

Circle number (131) on reply card.

High alloy castings . . . resistant to corrosion, high temperatures, and abrasion . . . are covered in 20-page Bulletin G-159. *The Duraloy Company.*

Circle number (132) on reply card.

Just one vote . . . and the effect it can have on a vital national issue . . . is subject of a revealing booklet which emphasizes importance of voting to the preservation of the competitive free enterprise system. *The Bureau of National Affairs, Inc.*

Circle number (133) on reply card.

Liquid process moisture monitor . . . Type 26-312 . . . reputed to be the only instrument capable of continuously analyzing water concentration in organic-liquid streams . . . is detailed in Bulletin 26312. *Consolidated Electrodynamics Corporation.*

Circle number (134) on reply card.

"Low First Cost vs Low Ultimate Cost"... new 12-page booklet . . . points out cost engineering factors to be considered in buying heat transfer equipment. *Western Supply Company.*

Circle number (135) on reply card.

Mathematical applications of the Dynamic Storage Analog Computer . . . are detailed in a 16-page technical report illustrated with full schematics of computer circuitry. *Computer Systems, Inc.*

Circle number (136) on reply card.

Mercury barometers and manometers . . . are described and various design elements which may affect the achievable accuracy are discussed in Monograph 8. 40 cents. *National Bureau of Standards.*

Circle number (137) on reply card.

Meters, feeders, controls . . . are among products and systems described in General Bulletin 0001.20-1. *B-I-F Industries.*

Circle number (138) on reply card.

Photodrawings . . . new graphics concept in which photography and line drawing are combined to obtain greater readability and accuracy at substantially lower cost than conventional engineering drawings is subject of Bulletin B-10M3. *Photodrawing Group, LogEtronics, Inc.*

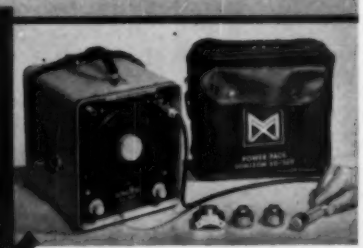
Circle number (139) on reply card.

Piping systems . . . fabricated and erected for power stations and industrial plants throughout the country are highlighted in 24-page Bulletin 60B, which also details company's complete line of welding fittings and flanges. *Midwest Piping Company, Inc.*

Circle number (140) on reply card.

Completely NEW Portable ULTRASONIC TEST UNIT...

The Fully Transistorized SONIZON SO-300 by MAGNAFLUX



- Measures thickness instantly from one side only.
- Spots corrosion and thin wall in pipes, tanks, valves, casting core shift, etc.
- May be used on practically any solid—from .025 to 2.50" thick.
- Direct readings—as fast as a probe can be moved over the surface.
- Lightweight — measuring unit only 12¼ lbs.
- Easy-to-use—select the range and turn a dial.
- Both quartz and the more sensitive lithium sulphate transducers may be used.

Ruggedly built for industrial use, the new Sonizon SO-300 provides instant engineering-accurate measurements, on steel, cast iron, brass, nickel, magnesium, hard rubber and plastics. Accuracy to ±1% is assured when calibration is checked against known sample of same material.

Complete with high impact-proof carrying case and battery case. Write for further information or demonstration —MAGNAFLUX CORPORATION, A Subsidiary of General Mills, 7337 West Ainslie Avenue, Chicago 31, Illinois.

MAGNAFLUX CORPORATION
General Mills
TEST SYSTEMS

New Triple-Eye firm to specialize in ultrasonic inspection of piping

A new Houston-based company, International Inspection, Inc., or Triple-Eye, will offer the oil industry the advanced inspection techniques originally developed for the missile and aircraft industries.

Triple-Eye, a subsidiary of Welex, Inc., wireline service company with headquarters in Fort Worth, Texas, will specialize in ultrasonic inspection of refinery and petrochemical plant piping and vessels for corrosion and oil field tubular goods. Welex is a subsidiary of Halliburton Company, Duncan, Oklahoma.

The new company recently purchased all ultrasonic patents, processes, and other assets of Electro-Circuits, Inc., a former subsidiary of Automation Industries, Inc., Los Angeles.

The Triple-Eye system, which features hot-line, onstream inspection of refinery equipment, permits continuous monitoring of corrosion rate without having to halt refinery operation for inspection. Heart of the system is a focused ultrasonic transducer, which allows a hairline width of ultrasound to be focused on tubular goods and other metallic material. Ultrasonic impulses are transformed onto an inked chart, thus providing a permanent record of wall thickness, minute fatigue cracks, corrosion pitting, wear and hidden flaws, and condition of welds, tank bottoms, pressure vessels, and other equipment.

Using this system, a Triple-Eye inspection engineer and crewman can perform a 100% inspection of thousands of feet of refinery tubing each day.

Process equipment . . . including liquid-liquid extractors, distillation and gas absorption equipment, mist extractors, and entrainment separators . . is detailed in Bulletin 27. *Otto H. York Co.*

Circle number (141) on reply card.

Refinery stream corrosion and fouling problems . . . are subject of a 5-bulletin technical file. Includes information on corrosion control, what makes inhibitors work, how corrosion programs may be evaluated. *Nalco Chemical Company.*

Circle number (142) on reply card.

Sliding gate and plate temperature regulators . . . are subject of Catalog J180-1 which gives features, applications, sizing charts, flow curve, sample specifications, and complete engineering information. *OPW-Jordan Corporation.*

Circle number (143) on reply card.

Stored-energy metal-clad switchgear . . . is described in profusely illustrated 20-page 2-color Bulletin 2801-2A. Gives construction and performance features, ratings, dimensions. *I-T-E Circuit Breaker Company.*

Circle number (144) on reply card.

Subsurface drainage . . . with Transite perforated asbestos-cement pipe is explained in Bulletin TR-246A. *Johns-Manville Corporation.*

Circle number (145) on reply card.

Temperature and Pressure Recorders . . . are subject of Catalog 800, which pictures spiral bourdon tube and bellows type pressure elements and lists materials and performance characteristics. *U. S. Gauge Division of American Machine and Metals, Inc.*

Circle number (146) on reply card.

Terms used in liquid metering . . . are defined in glossary compiled by Howard E. Rittenhouse, Chief Engineer, Petroleum and Industrial Liquid Meters, Statesboro Plant. *Rockwell Manufacturing Company.*

Circle number (147) on reply card.

Thermocouple assemblies and pressure sealing glands . . . are discussed and illustrated in 32-page Catalog 1890. *Conax Corporation.*

Circle number (148) on reply card.

"Twin-Air" . . . rotary screw type air compressors which deliver from 6900 to 19,400 cu ft of air per minute at 110 psi, are described in Folder A-1141. *Atlas Copco.*

Circle number (149) on reply card.

Ultra-Lightweight Gas Turbines . . . designed for applications which include fluid and gas pumping, electric power generation, and marine and vehicular propulsion are subject of Bulletin GEA-7083, "New Dimensions in Lightweight Gas Turbine Power." *General Electric Company.*

Circle number (150) on reply card.

Ultraviolet, infrared, and mass spectral data . . . is contained in first of a proposed series of spectral data sheets on organic compounds. 10 cents. *Manufacturing Chemists' Association.*

Circle number (115) on reply card.

FAST, Lightweight
Greenlee Hydraulic Benders for 1/2"-4" Conduit and Pipe

full 90° bend with one ram stroke

NEW GREENLEE No. 883 Lightweight Hydraulic Pipe Bender quickly makes accurate bends in eight sizes of pipe from ½" through 3" . . . up to 90° with one ram stroke. Operates with either a portable power pump or hand pump. Makes 90° bend in 3" pipe in approximately 1 minute with power pump . . . only 10 minutes with hand pump. One set of rotating supports for all eight pipe sizes . . . supports also serve as rollers for wheeling bender from job to job. Pipe is easily inserted and removed from front of bender. "Quick-removal," positive-locking support pins cannot come loose. Bending gauge included for accurate results with minimum calculations. Get details now on the complete GREENLEE Lightweight Bender line that includes three models for ½" - 2" . . . ½" - 3" . . . and ½" - 4" pipe.

new, fast ratchet bender for ½", ¾", 1" pipe

GREENLEE No. 1800 Ratchet Hand Bender permits short, powerful strokes for easy, quick bending up to 90°. Swing-away clamp makes loading simple. Sturdy T-iron base sets anywhere or receives threaded pipe legs of any desired length. Built-in bending gauge reads 0 to 90°. See your distributor for a demonstration, or write for descriptive Bulletin E-291.

A COMPLETE LINE OF HYDRAULIC AND HAND BENDERS FOR PIPE AND TUBING

GREENLEE TOOL CO.

1757 Columbia Ave., Rockford, Illinois

GREENLEE

PETRO/CHEM newsmakers

▸ **I. E. Levine** is a new vice president of California Research Corporation in charge of the chemicals research department, succeeding **J. Q. Cope,** transferred to California Chemical Company. Other promotions:

H. M. Lavender, manager, chemicals research division, Richmond laboratory, succeeding Levine.

J. F. Senger, manager, process engineering division, Richmond laboratory, succeeding Lavender.

E. B. Chiswell, California Chemical Company, senior coordinator, process design and engineering, San Francisco office, succeeding J. F. Senger.

▸ Continental Oil Company announces appointments of:

Paul E. Geiser, general manager of petrochemical manufacturing, Houston. He was manager of the detergents division, Houston.

K. R. Gerhart, assistant general manager of petrochemical manufacturing, Houston. He was superintendent of the Gretna, Louisiana, petrochemical plant.

Edwin J. Jennings, Jr., technical assistant to the general manager of manufacturing, Houston. He was senior process engineer at the Ponca City, Oklahoma, refinery.

▸ **Paul V. Keyser, Jr.,** heads the newly formed Mobil Chemical Company, an operating division of Socony Mobil Oil Company, Inc., that will carry on broad-scaled activity in the petrochemical industry both in the United States and overseas. Keyser, formerly a senior vice president of Socony Mobil, is now an executive vice president of the parent corporation in addition to being president of the new chemical organization.

P. W. Judah has been named manager of the basic petroleum chemicals and the paint and special products divisions of Mobil Chemical. He has been serving as manager of Socony Mobil's petroleum chemicals department.

▸ At Gulf's Port Arthur, Texas, refinery, **Eric B. Hjerpe** is new director of the operations planning and scheduling division, replacing **Marvin L. Ralston,** recently transferred to the corporation's general offices in Pittsburgh. **Herman Taylor, Jr.,** has replaced Hjerpe as supervisor, special projects section, process engineering division.

▸ Three Universal Oil Products employees recently completed 40 years' service with the company:

Dr. Donald J. Bergman, engineering consultant and former chief engineer.

Fred J. Ritz, superintendent of plant construction and maintenance at the Riverside, Illinois, facility.

Edwin T. Steele, in charge of drafting at Riverside.

▸ **Lee P. Morris** is a new assistant manager of the Hawaiian refinery of Standard Oil Company of California, Western Operations, Inc. He has been refinery manager of the American Gilsonite installation at Grand Junction, Colorado.

▸ **Robert B. Sykes** and **Leslie T. Larson** are now projects managers in the engineering organization, manufacturing department, Amoco Chemicals Corporation, Chicago.

▸ **E. F. Battson,** New York, has been elected president of Refineria Panama, S.A., which will operate a $30,000,000 refinery being built in Panama. Company is owned jointly by a Continental Oil Company subsidiary and interests of National Bulk Carriers, Inc. Battson is a former Conoco vice president.

▸ **J. W. Braun** is new superintendent of the refining section of Atlantic Refining Company's Philadelphia refinery, succeeding **Dr. H. V. Hume,** who is retiring after 33 years service. Braun was superintendent of the chemicals section.

▸ **Don F. Ferguson** has joined Hydrocarbon Construction Company, Houston, as vice president in charge of the petroleum refinery division. He is former sales manager of Treco of Tulsa.

▸ **Paul E. Ditto** has been named technical service manager of B. F. Goodrich-C. S. R. Chemicals Pty. Ltd., a chemical company recently established in Australia by B. F. Goodrich Chemical Company,

ZYGLO®

find cracks, leaks, defects with push-button ease!

BLACK LIGHT portable fluorescent penetrant inspection kit by MAGNAFLUX

IDEAL FOR
- Finding oil leaks
- Maintenance inspection
- Testing cast or machined parts during manufacture
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Take the guesswork out of testing! ZYGLO, the *most sensitive* fluorescent inspection method available, makes every crack glow. Use it anywhere —in the shop, in the field.

Complete ZYGLO KIT shown above including 100 W. BLACK LIGHT $125.00 F.O.B. CHICAGO

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BW STEAM HOSE

- PRACTICALLY BURST-PROOF
- STATIC WIRE
- STEEL WIRE BRAID REINFORCED
- BUTYL COVER
- FOR PRESSURES TO 200 LB—(388° F)

WRITE FOR BULLETIN M630

Unusual strength and flexibility . . . maximum safety. Preferred by safety engineers for flash-fire protection, clean-up in refineries, steel mills, foundries . . . dock-to-ship steam supply lines. Made with Neoprene cover for refinery service. Master brand for 150 lb. pressure. Special Type for Pile drivers. Other engineered variations for special applications (higher pressures, temperatures, etc.) on request.

RM1036

RAYBESTOS-MANHATTAN, INC.
MANHATTAN RUBBER DIVISION, PASSAIC, NEW JERSEY
ENGINEERED RUBBER PRODUCTS . . MORE USE PER DOLLAR

Cleveland, and C. S. R. Chemicals Pty. Ltd., Sydney, Australia. He has been senior technical representative for BFG Chemical's international department.

▸ Stone & Webster Engineering Corporation announces election of three vice presidents.

J. Marshall Hamill, administrative assistant to the president in the Boston office.

Theodore E. Casselman, Jr., manager of the New York office.

Wilbur S. Roberts, Jr., manager of new business activities.

▸ **H. H. Dronberger** has joined the engineering division of Sumner Sollitt Company, Chicago, as specialist in design of terminals and lube oil blending, packaging, and distribution facilities. Dronberger formerly was manager of Pure Oil's Toledo refinery.

▸ **F. B. Langreck,** retiring technical advisor to the general manager of Monsanto Chemical Company's research and engineering division, has been named an affiliate professor of chemical engineering at Washington University.

▸ **D. R. Zachry** has been elected president of Delta Refining Company, with headquarters in Dallas. He recently resigned as executive vice president of American Petrofina Company of Texas. Zachry is former executive vice president of American Liberty Oil Company, purchased by American Petrofina of Texas in 1957.

▸ **John D. McPherson** is new president of Jefferson Chemical Company, Inc., succeeding **George R. Bryant,** who is retiring from active service. McPherson has been executive vice president of Jefferson Chemical, owned equally by Texaco, Inc. and American Cyanamid Company.

▸ **Dr. Herman A. Bruson** has been named vice president for research of the chemicals division, Olin Mathieson Chemical Corporation, with headquarters at the corporation's new research center in New Haven, Connecticut. He formerly was director of research, organic chemicals.

▸ **Ernest Artz** has joined SunOlin Chemical Company, Philadelphia, as process engineering assistant. He formerly was superintendent of operations at the U. S. Air Force high energy fuel plant operated by Olin Mathieson Chemical Corporation at Model City, near Niagara Falls, New York.

▸ **Dr. Alfred E. Hirshler** has been appointed research associate and **Dr. Richard S. Stearns** has been named chief of the polymers, lubes, and wax section—both in basic research—in Sun Oil Company's research and development division, Marcus Hook, Pennsylvania.

▸ Humble Oil & Refining Company's technical division, Baytown, Texas, has promoted:

W. D. Allison to senior supervising engineer.

B. A. Martin and **R. B. Nesbitt** to senior chemical engineers.

E. J. Pratt to staff engineer.

▸ Appointed to key positions at Continental Oil Company's Ponca City, Oklahoma, refinery are:

Wyatt L. Walker, named assistant refinery superintendent in charge of the light oil and lubricating oil divisions. He succeeds **C. B. Round,** recently promoted to manufacturing manager for the Rocky Mountain region at Denver.

L. S. Burke, made assistant superintendent of the refinery in charge of the catalytic and thermal cracking divisions, succeeding Walker.

Lowell H. Betow, promoted to superintendent of the thermal cracking division, replacing Burke.

▸ **Joe H. Miller** has been named manager of process and control engineering for Suntide Refining Co., Corpus Christi, Texas. He was chief process engineer for DX Sunray Oil Co.'s Tulsa, Oklahoma, refinery. Suntide and DX Sunray are both Sunray Mid-Continent Oil Co. subsidiaries.

▸ **James F. Vanicek** has been appointed a section leader at the Whiting research laboratories of Standard Oil Company (Indiana). He will direct studies of the economics of new processes in petroleum refining.

Two research scientists at the Whiting laboratories have been named officers of the Catalysis Club of Chicago. They are **Dr. Edmund Field,** senior research associate at Standard, chairman of the club, and **Dr. Herman E. Ries, Jr.,** research associate member of the club's executive committee.

▸ **Dr. Edwin H. Young,** professor of chemical and metallurgical engineering at the University of Michigan, recently was installed as vice president of the Michigan Society of Professional Engineers.

For the

OIL INDUSTRY

Thermocouples
Compensating leads
Resistance thermometers

in many forms specially suited to individual working conditions.

"SCOT" FORGED SEAMLESS RING GASKETS

MINIMUM HARDNESS

Ask for "SCOT" Gaskets at your Supply Store.

For ring Groove Flanges forged from reforging billets in the following materials in stock: Soft Iron, Copper, Aluminum, Inconel, Monel, Nickel; 1¼ Cr ½ Mo., 2¼ Cr 1 Mo., 9 Cr 1 Mo. 304, 310, 316, 321, 347, 405, 410, 430, 502, 304L, 316L, Nickel L, Kel F, Teflon.
Machined in all A.P.I.—A.S.A.
Special sizes and other type, Including BX.

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TiteSeal®
SEALING COMPOUNDS

Heat and vibration-proof, non-solvent, will not shrink, crack or crumble. Makes all assemblies leak-proof and pressure-tight. Prevents rust, corrosion and joint seizure.

7 BASIC BLENDS

LIQUID WRENCH

LOOSENS RUSTED BOLTS

A powerful blend of fast-acting solvents that literally "melt the rust away"—safe on all metals and alloys.

RADIATOR SPECIALTY CO.
CHARLOTTE, N. C.

Sealing Corrosives?

Teflon* Gaskets and "O" Rings Definitely Reduce Costs

... last for the life of the connection even in services such as concentrated acids, alkalis or solvents (except molten alkali metals).

... permit easy joint breaking without tearing or pulling—eliminate replacement cost and lost maintenance time for refinishing flange surfaces.

... can be used again and again—assure decided savings where joints must be frequently broken for cleaning and inspection.

Reduce *your* corrosive sealing costs with John Crane Teflon Gaskets, "O" Rings and Back-Up Rings. They are available in a full range of types and sizes, envelope or solid, also specials to specification. Request Catalog P-327 for complete facts.

Crane Packing Co., 6486 Oakton St., Morton Grove, Ill. (Chicago Suburb).
In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

**DuPont Trademark*

John Crane — MECHANICAL PACKINGS · SHAFT SEALS · TEFLON PRODUCTS · LAPPING MACHINES · THREAD COMPOUNDS

CRANE PACKING COMPANY

Processing Parade

Lucey Products Corporation, Tulsa, Oklahoma, has established a refinery, chemical plant, and pipeline department. **C. Ray Grosvenor** will serve as manager of the department, which will supply equipment and materials for new plants, new units, plant revamps, refinery turnarounds, and day to day maintenance.

Thompson Ramo Wooldridge Inc. will manufacture and sell its RW-300 digital control computer in the European Common Market through a newly formed corporation headquartered in Paris. The new corporation, Compagnie Europeenne d'Automatisme Electronique, is a joint venture of TRW, Compagnie Generale de Telegraphie Sans Fil, and Intertechnique of France.

The Oil and Gas Supply Company, Houston, has been appointed a gas and petroleum industry representative for certain AiResearch gas turbines and turbomachinery lines.

Trinity Steel Company, Inc., Dallas, announces appointment of two sales engineering firms as custom fabrication representatives — Cudmore Supply Company, 30 Church Street, New York, for the metropolitan New York City area and The Allred Company, Atlanta, for the states of Alabama, Georgia, Tennessee, North and South Carolina.

Smithco Engineering, Inc., manufacturer of air cooled heat exchangers, is increasing the manufacturing area of its West Tulsa, Oklahoma plant by more than 50%.

Appointments

C. D. Carter, export sales manager, Ethyl Corporation, New York.

John J. Griffin, head of industrial sales, and **Harold F. Koons,** sales engineer, John Zink Co., Tulsa, heating equipment manufacturers.

John B. Cruell, manager of the Southern California district, and **John H. Gallagher,** manager of the New York City office, Nalco Chemical Company's industrial division.

Dr. Ernest O. Ohsol, vice president in charge of chemical operations, Haveg Industries, Inc., Wilmington, Delaware.

J. P. Knopf, vice president, Tube Turns Plastics Inc., Louisville, Kentucky.

Daniel P. Brennan, technical service representative, midtown New York City, Oakite.

R. P. Stuntz, manager of field sales, and **L. D. Christie, Jr.,** Product manager, technical sales, Babcock & Wilcox Company's refractories division.

Robert E. Green and **Richard Henke,** operators of the new Denver store; **Roy R. Rohrer,** district manager, Houston, and **Joe B. Byrd,** Houston staff, Western Supply Company, Tulsa.

Paul E. Paules, western regional manager, scientific and process instruments division, Beckman Instruments, Inc., Fullerton, California.

W. F. Bliss, Jr., product sales representative for the Gulf Coast area, operating out of Houston, Universal Oil Products Company.

PIPELINE Engineer

Engineering and Operating Section

ALLIED CHEMICAL'S HOTLINE ENAMEL—LOW-COST, LASTING PROTECTION FOR HOT POWER LINES

Allied Chemical's Hotline Enamel provides oil-o-static lines without a rugged outer coating. It prevents corrosion that leads to oil leaks—a vital power line factor.

Proved on-the-job—Allied Chemical *Job-Matched* Hotline Enamel's protective coating shields against the damaging effects of soil stress, internal electrical heat, and the corrosive effects of water and soil chemicals. Proved in laboratory tests—a one year immersion in salt water solution revealed high resistivity whereas *all* asphalt enamels showed very low resistivity. Proved in company balance sheets—not only is Allied Chemicals Hotline Enamel's initial expense far below asphalt mastic, it also repays itself over the years with worry-free protection.

Provides improved protection under these conditions:

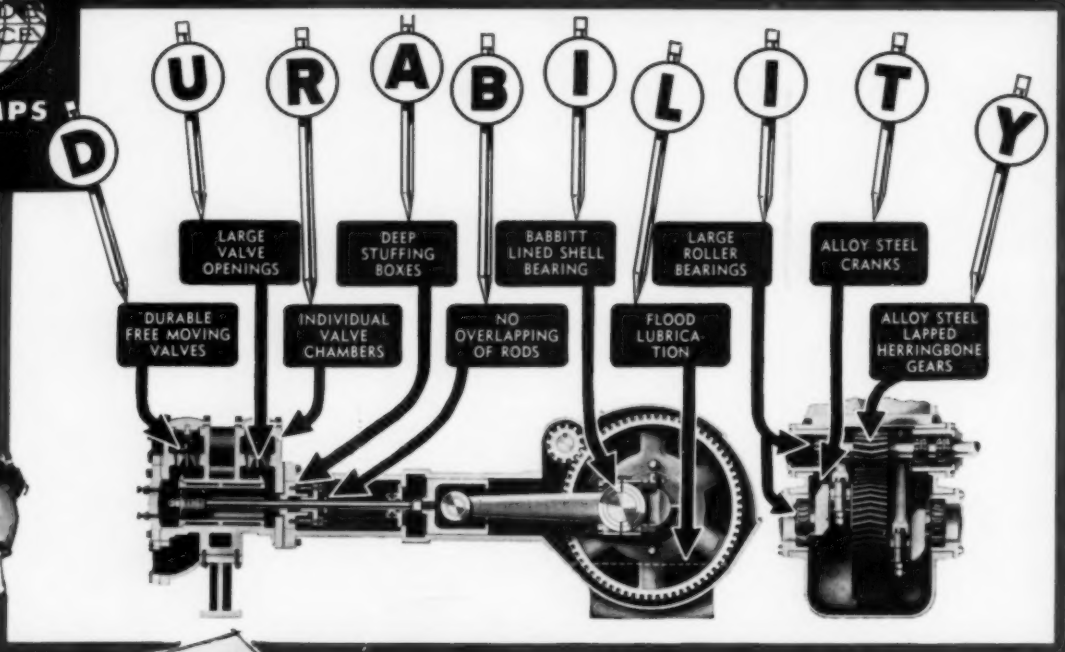
1. On pipe type cables or "oil-o-static lines" subject to internal electrical heat. (Up to 180° F. down to –10° F.)
2. Warm, swampy areas or other places where excessive soil stress is encountered.
3. Areas where backfill and trenches are rough, rocky or contain foreign objects which penetrate softer coatings.
4. Hot gas pipelines, on discharge side of compressor stations where line is above 120° F.
5. Pipelines (such as heated fuel lines) where temperatures are consistently high most of the time.

Field Service Experts are at your call for technical assistance that can save you maintenance time and costs.

PLASTICS AND COAL CHEMICALS DIVISION
40 Rector Street, New York 6, N. Y.

Allied Chemical

GASO PUMPS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NO OVERLAPPING OF RODS
FLOOD LUBRICATION
ALLOY STEEL LAPPED HERRINGBONE GEARS

NOTHING "ACCIDENTAL" ABOUT GASO PERFORMANCE

It's DESIGN that Explains Why Gaso Pumps Perform Better, Last Longer

There's no mystery about the extra years of trouble-free service you get from Gaso Pumps. It's all a matter of DESIGN.

Every detail of Gaso design is the development of 45 years' concentration on oil-industry pumping needs. Every part from main frame to gaskets reflects Gaso's continuous search for metallurgical and engineering advances which contribute to the goal of *maximum* performance and *minimum* upkeep, achieved with *fewer* parts made *extra-strong*.

In other words, it's the absence of weak spots in both design and components that explains the *bonus* of performance you get from Gaso Pumps.

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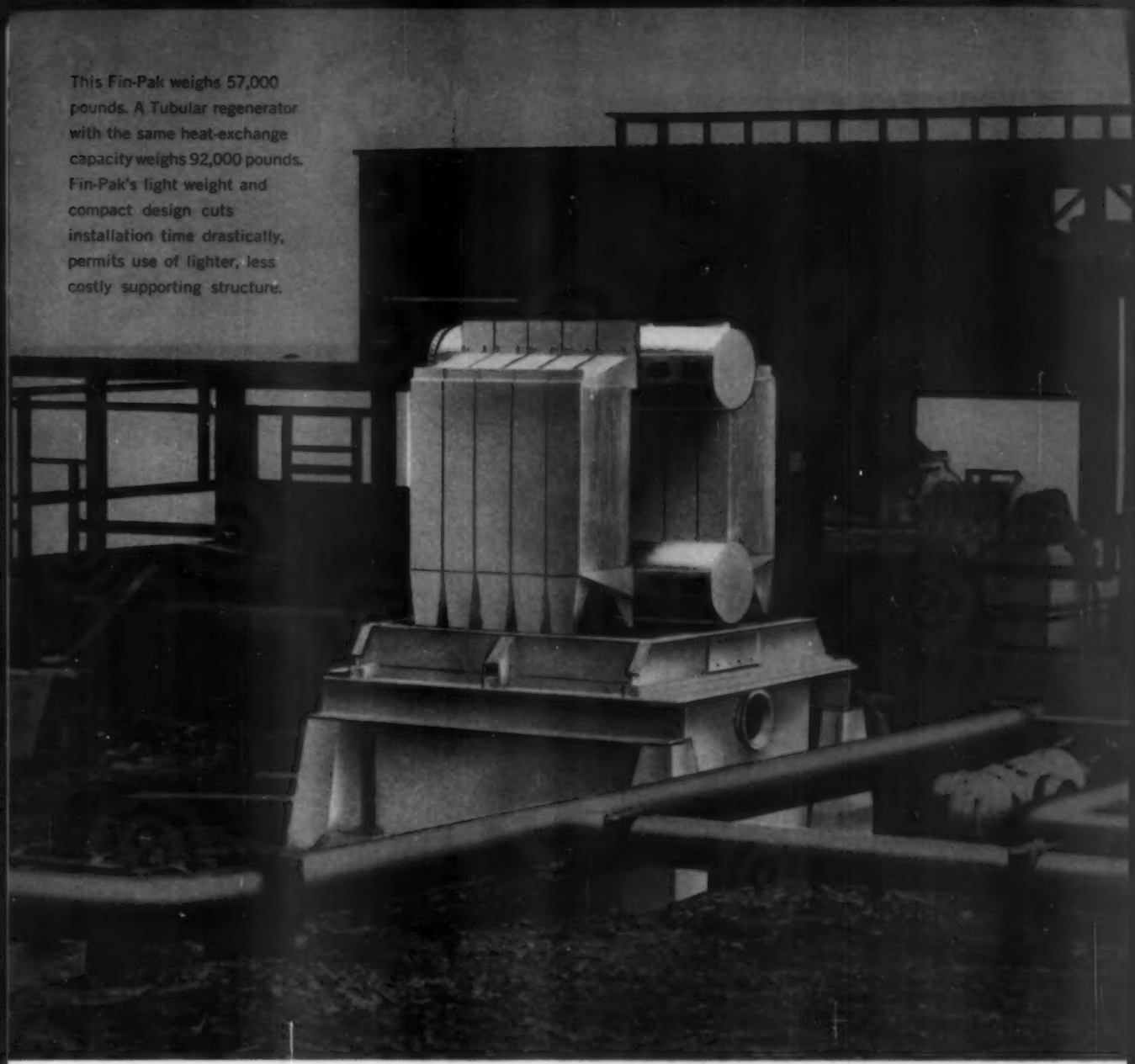
This Fin-Pak weighs 57,000 pounds. A Tubular regenerator with the same heat-exchange capacity weighs 92,000 pounds. Fin-Pak's light weight and compact design cuts installation time drastically, permits use of lighter, less costly supporting structure.

MOST EFFICIENT HEAT RECOVERY UNIT FOR GAS TURBINES ALSO EASIEST-TO-INSTALL: **FIN-PAK**®

If easy installation is one of the big reasons you chose gas turbines for compressor station power, Fin-Pak is good news. Fin-Pak can be installed completely in less than 500 man-hours*—less time than it takes to install a tubular heat exchanger of the same capacity. That's because the Fin-Pak is only half the size of a tubular regenerator of equal capacity, and weighs only half as much.

Fin-Pak cuts fuel bills 30%, too.** What you save on fuel can write off the cost of the Fin-Pak within two years. And a Fin-Pak needs almost no maintenance except for an occasional cleaning with compressed air.

All these advantages add up to the fact that nothing can move so much gas so economically as a gas turbine equipped with a Fin-Pak. For more information about the Fin-Pak, including actual performance records of units now in operation, call or write The Air Preheater Corporation.

**On a 5,000-hp gas turbine.*
***An 80% effective Fin-Pak in a gas turbine cycle at 6 to 1 pressure ratio and a turbine inlet temperature of 1,500°F can reduce fuel consumption by more than 30%.*

THE AIR PREHEATER CORPORATION

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KEEP MOVING... SWAMP

Sure-footed flotation saves you in soft going. Power and balance keep you rolling on steep slopes. All along the line you get money-making performance from Allis-Chalmers side boom tractors.

Allis-Chalmers' big side boom tractors have a *reputation* among pipeliners for walking right through gooey swamps that are out of bounds for other pipe layers. Long, wide tracks stay on top of mud. But it's more than just square inch of ground contact. Allis-Chalmers tractors have exactly the right combination of weight, center of gravity and clearance to stay afloat where other equipment bogs down.

They're agile climbers, too, with a combination of excellent balance and big power. From the 99-hp HD-11 to the 225-hp torque converter HD-21, Allis-Chalmers tractor engines have the deep-down lugability for steep hillside work.

Durability and safety are built in, too, with waterproof, internal-expanding side boom brakes . . . dropproof hydraulic counterweights . . . shock-absorbing,

move ahead with

OR MOUNTAIN

all-steel tractor main frame . . . durable, double-reduction final drives . . . toughest track ever made. Certified permanent lubrication of tapered roller bearing truck wheels, idlers and support rollers eliminates greasing — saves time and cost.

Your Allis-Chalmers dealer will give you moneysaving proof why the 127,000-lb capacity HD-21, the 78,000-lb capacity HD-16, and the 40,000-lb capacity HD-11 are your best tractor buys — come swamps, mountains or biggest inch pipe. Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

power for a growing world

"DOES WORK OF TWO DITCHERS HANDLING ALL 3 OF MY JOBS"

Pipeliner Pete Gallatin calls Barber-Greene Model 774 Ditcher "most modern, advanced construction machine...completely new ditching concept"

Pipeline construction company president Pete Gallatin knows increasing ditching production by 100% is as easy as changing machines—stepping up to a Model 774 Barber-Greene with 7-ft. wheel —the industry's biggest buy because it outdigs and costs 50% less than any other 7-ft. ditcher.

He reports: "My company handles virtually every phase of pipelining and for five years I used other ditchers. But this Model 774 Barber-Greene opened my eyes from the start—does the work of two same-size ditchers and trenches so fast I can keep all three of my jobs in Michigan and Illinois moving by shuttling it back and forth. It not only gives me 100% more production, but it excavates boulders and rocks far easier than other ditchers I owned. For my money, it's the most modern, advanced construction machine on the market with a completely new concept of digging—not just an alteration to existing equipment."

Exclusive dual-range Hydra-Crowd transmission makes the big difference. Operators dial *instantly* the maximum crowding speed for any ground condition, or reverse *instantly*, too. They select from *infinitely variable* crowding speeds *independent* of wheel and conveyor drive. No four-operation gear shifting. No guessing about gear ranges. No stopping to change speeds.

Check with your Barber-Greene Distributor and see why Hydra-Crowd and these additional features are found exclusively in the only modern ditcher line: Flexible drawbar between chassis and boom; all-hydraulic spoil conveyor independent of wheel speeds; hydraulic controls for greater line-and-grade-holding accuracy; crawler adjusted 10 times faster than those on ordinary ditchers; and automatic electric overload protection.

Barber-Greene 774 has ditched more than 50 miles for Gallatin by being shuttled between Michigan and two Illinois job sites.

Gallatin's 774 is shown digging trench for gathering lines for Marathon Pipeline Co., near Mosherville, Michigan.

Model 772 (shown) is your best buy for the general utility range—cutting widths from 10-24" and to 5' 6" deep. Model 773 varies only in its wider track gauge.

Manufacturer of the only modern ditcher line

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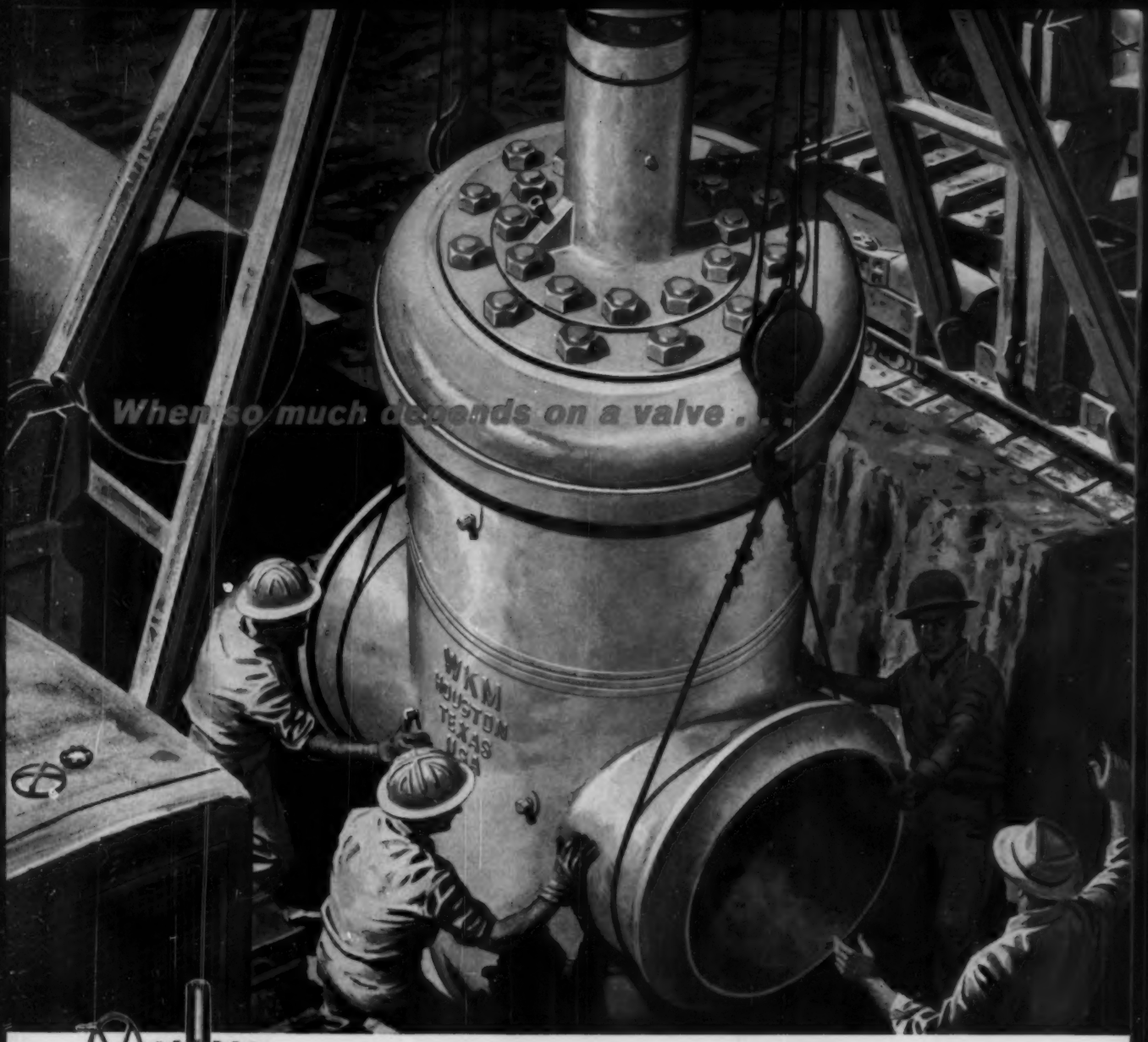
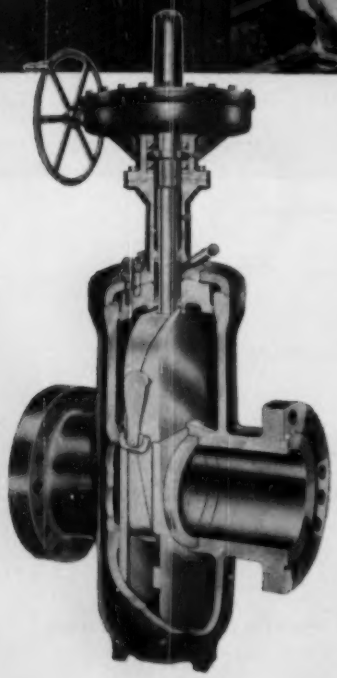




W-K-M Expanding Gate Valves seal positively with *controlled force*

You exert unique control over the seating in W-K-M Expanding Gate Valves. Fully opening or closing the gate causes it to *expand*. So you can make as tight a seal as you want . . . first Teflon-to-metal, then metal-to-metal.

This extra degree of control insures maximum dependability over long periods of use or disuse . . . under a wide range of temperatures and pressures . . . with all pipeline ladings.

The exclusive W-K-M Expanding Gate is a big reason why W-K-M pipeline valves outnumber any other valve in mainline service. Specify them.

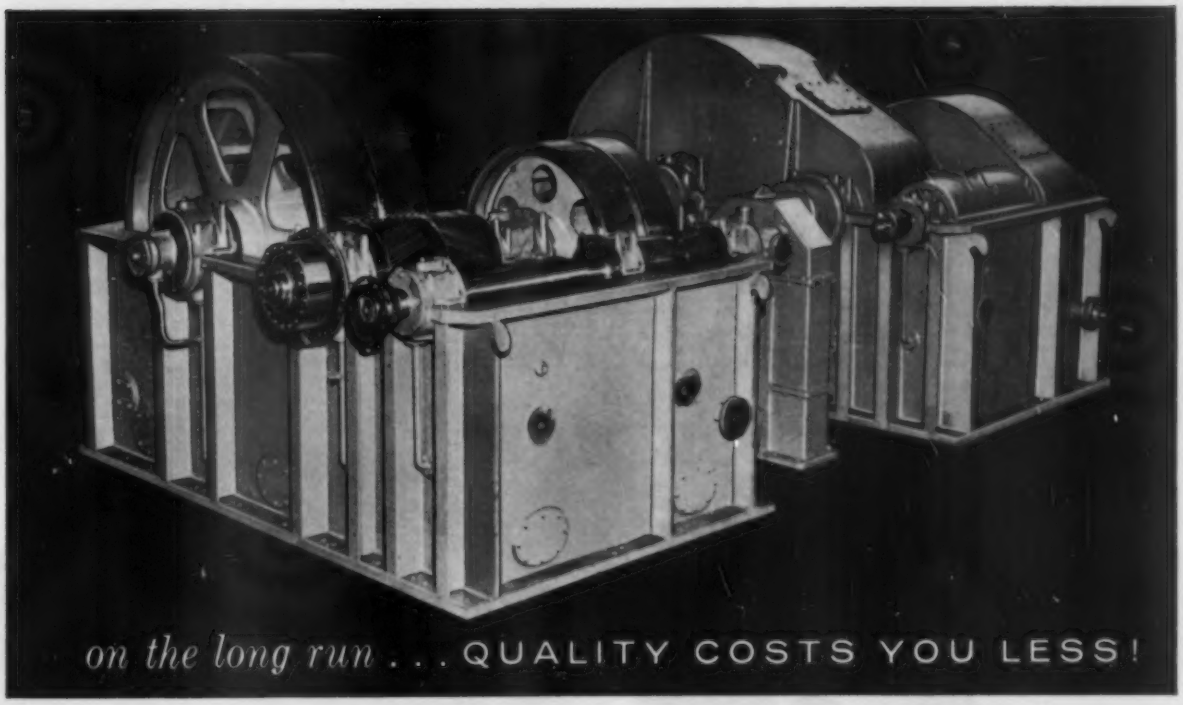
Exclusive expanding gate is full-bore, seals positively upstream and down.

Sizes: 2" through 12" at leading supply stores; sizes through 36" on special order.

Pressures: ASA 300 through ASA 1500 lb.

W-K-M DIVISION OF ACF INDUSTRIES INCORPORATED
P. O. BOX 2117, HOUSTON, TEXAS

6003



WESTERN GEAR HIGH SPEED PIPELINE DRIVES CHOSEN FOR TRANSWESTERN PIPELINE FOR...

EFFICIENCY — Western Gear high precision manufacture guarantees low power losses through the gear drive ... a vitally important factor in the high proven efficiency of engine driven pipeline centrifugal compressors. Certified factory full-load, full-speed tests show a maximum of 2.0% loss through the 5,000 horsepower 2-stage drives pictured. Truly exceptional, considering the unit size and relatively high speeds encountered ... over 6,000 r.p.m. and 15,000 f.p.m. pitch line velocity.

DEPENDABILITY — Western Gear's unsurpassed application experience with 2-stage pipeline drives combined with years of close cooperation between Gulf-Interstate, Cooper-Bessemer and Western Gear engineers, assures dependability ... a Transwestern must. Rigid Western Gear quality control procedures include Magnafluxing, ultrasonic and X-ray inspection of vital parts, which afford maximum protection against sub-surface defects not discoverable by ordinary methods.

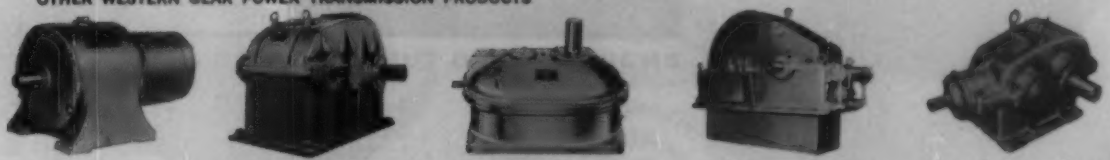
For full information on Western Gear pipeline drives, write, wire or phone: **INDUSTRIAL PRODUCTS DIVISION**
P.O. BOX 126 • BELMONT, CALIFORNIA • PHONE: LYtel 3-7611

WG INDUSTRIAL PRODUCTS DIVISION

Photo above shows one of twenty units installed over three years ago on Columbia-Gulf Pipeline (formerly Gulf-Interstate Pipeline). Units are of the 2-stage type similar to the ten units currently being supplied for Transwestern. Cooper-Bessemer natural gas engines capable of delivering 5,000 horsepower at 360 r.p.m. drive through Western Gear Corporation Model 4525THS20-16 pipeline drives to Cooper-Bessemer centrifugal compressors at 6,050 r.p.m.

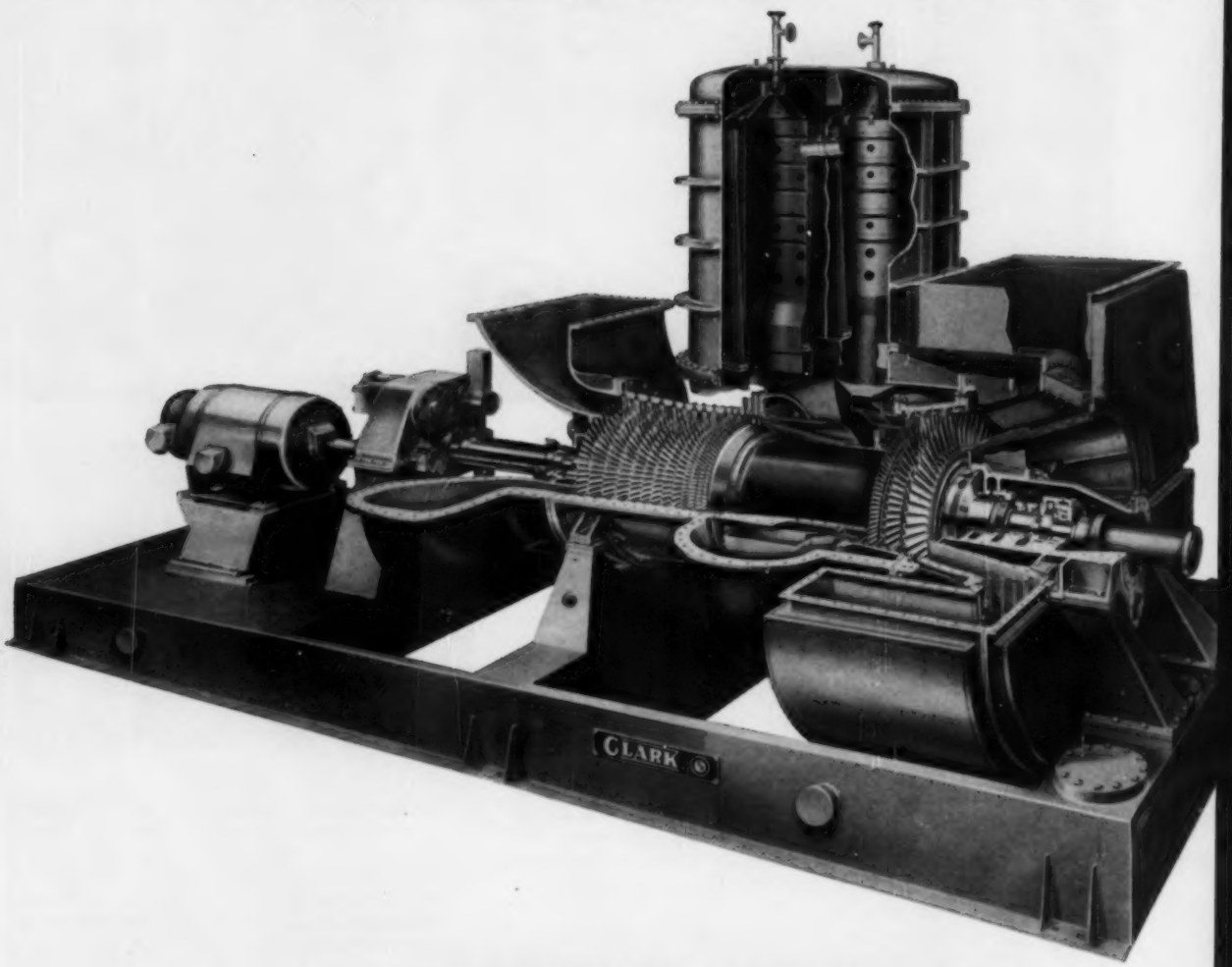
WG-6003

OTHER WESTERN GEAR POWER TRANSMISSION PRODUCTS



integral gearmotor | *parallel shaft reducer* | *vertical shaft reducer* | *high speed unit* | *right angle reducer*

No matter how you gauge PRIME MOVER COST...



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CLARK

DRESSER INDUSTRIES INC.
OIL • GAS • CHEMICAL
ELECTRONIC • INDUSTRIAL

ENGINES • GAS TURBINES • COMPRESSORS

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the CLARK 300 series of GAS TURBINES measures up fully to your needs

Name the norm . . . capital investment, floor space, installation or operating labor, general reliability, maintenance or all combined. Whatever you use to determine *real* prime mover cost, Clark heavy duty industrial gas turbines provide the most economical answer to your requirements. As an example of how these advantages work for you let us examine the latest addition to the Clark 300 series of turbines, the Model 305-S.

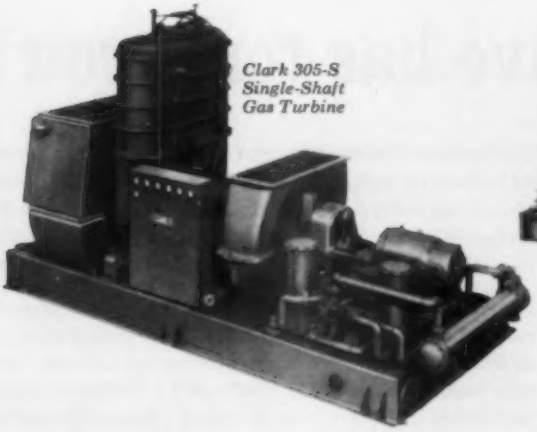
CONSIDER INITIAL INVESTMENT—This single-shaft open cycle machine is simplicity itself. With the axial compressor and three stage turbine mounted on the same shaft, parts . . . *and cost* are cut to a minimum.

FIELD PROVED RELIABILITY—Important components such as compressor and turbine blading are based on proved designs which have operated for thousands of hours in Clark Dual-Shaft Gas Turbines. Turbine inlet temperature is held under 1400° F to ensure extra long life and to provide a substantial margin of operating safety. The turbine is completely air cooled and suitable for operation in arid country. Pressurized air is bled off the axial compressor to cool turbine blade roots and other high temperature components. In addition, cool air envelopes between inner and outer skin surfaces reduce heat loss and minimize heat radiation.

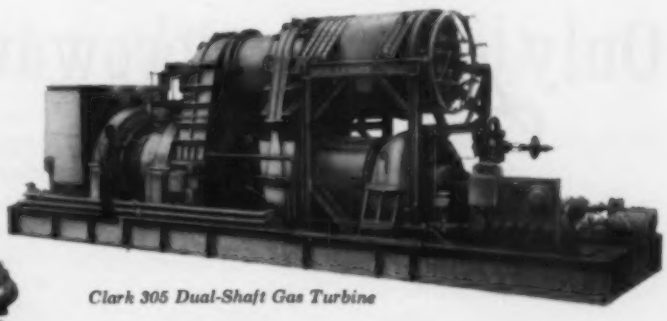
FLOOR SPACE INSTALLATION AND MAINTENANCE—The Clark 305-S is so compact it is mounted on a skid only 26 feet long. The combustion chamber with two parallel burners is placed over the rotor between compressor and turbine. You save on floor space, housing, transportation to the site, foundation and installation expense. Both the single and dual-shaft Clark gas turbine designs have provisions for easy access to blading, bearings and seals for inspection or maintenance.

VERSATILE TOO—Clark Series 300 Gas Turbines in the 8000-10,000 horsepower class provide the inherent flexibility to match the application. The dual-shaft models are excellent drivers for pumps or compressors on liquid or gas transmission lines, for marine propulsion, compressor drivers in repressuring or process plants and other uses requiring broad speed and loading flexibility. For applications that do not require the wide range flexibility of the dual-shaft machine such as base load or peaking turbogenerators the single-shaft units are ideal. Both designs burn either liquid or gaseous fuels.

Your Clark representative will gladly give you all of the cost saving details on Clark Gas Turbines. Consult him or write us direct. CLARK BROS. CO., OLEAN, NEW YORK.



Clark 305-S Single-Shaft Gas Turbine



Clark 305 Dual-Shaft Gas Turbine

Why you get more from Lenkurt Type 74A microwave–

Only *Lenkurt* microwave has tomorrow's

The Federal Communications Commission has proposed an immediate tightening of microwave frequency tolerances from today's ± .05% to ± .005%. Industry representatives have counter-proposed an immediate reduction to ± .02%, with a further reduction to ± .01% in 1965.

Lenkurt Microtel microwave equipment, alone, *already* meets the ± .02% requirement *without modification or additional equipment*. In fact, *existing* installations, with only a minor modification, will be able to hold a tolerance *better* than ± .01% . . . *better* than the industry's recommendation for 1965!

frequency stability already built in

Lenkurt Microtel achieves this performance because circuits and components were designed with tomorrow in mind. The heavy-duty one-watt klystron and the Invar reference cavity, for instance, neither use nor require temperature control to meet specifications. And automatic frequency control of the transmitter is *standard* on Lenkurt Microtel . . . it's not even available on most other microwave systems!

Our customers have come to expect such advanced thinking and engineering in all Lenkurt telecommunications products. Such "engineering for the future" saves you money, both in freedom from obsolescence and in greatly reduced maintenance expense.

With a complete product line, our experienced staff engineers are able to plan your systems efficiently and objectively. Call or write your nearest Automatic Electric representative, or the Director, Petroleum Industry Sales, Automatic Electric Sales Corporation, Northlake, Illinois.

AUTOMATIC ELECTRIC

Subsidiary of

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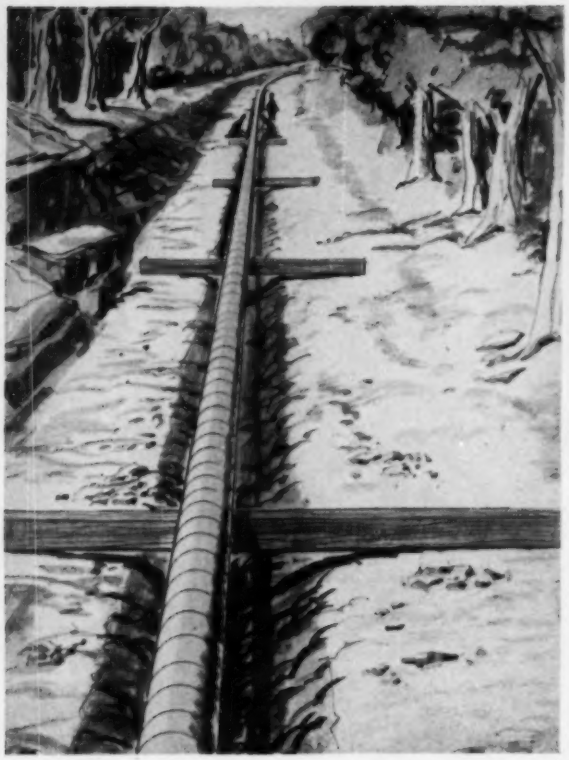
GENERAL SYSTEM



in the
petroleum industry

Duriron®
impressed current
Anodes

provide more positive
cathodic protection for
all types of structures

Duriron performs as well as graphite in all the easy services, and far outperforms graphite when the going gets tough in marshlands, at river crossings, or wherever it is impractical to use backfill.

Durco high silicon cast irons are resistant to sea, brackish and fresh waters as well as all soil environments.

Duriron Anodes have unexcelled corrosion resistance, good electrical properties, and they are easy to install. For real protection, get Duriron. Write for Bulletin DA/6.

STANDARD DURIRON ANODE SIZES

Type Anode	Size	Area Sq. Ft.	Weight (Lbs.)	General Application
B	1" x 60"	1.4	14	Fresh Water
C*	1½" x 60"	2.0	25	Ground Bed
D	2" x 60"	2.6	46	Ground Bed
E	3" x 60"	4.0	115	Salt Water
G	2" x 9"	0.4	5	Ducts
J	3" x 36"	2.5	80	Salt Water
M	2" x 60"	2.8	57	Salt Water

*Applicable also in fresh water service. Should not be used in ground beds without backfill.

THE DURIRON COMPANY, INC.
DAYTON, OHIO

DURCO

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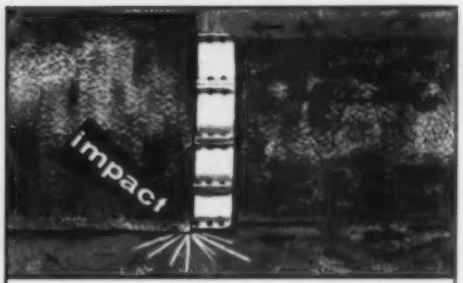
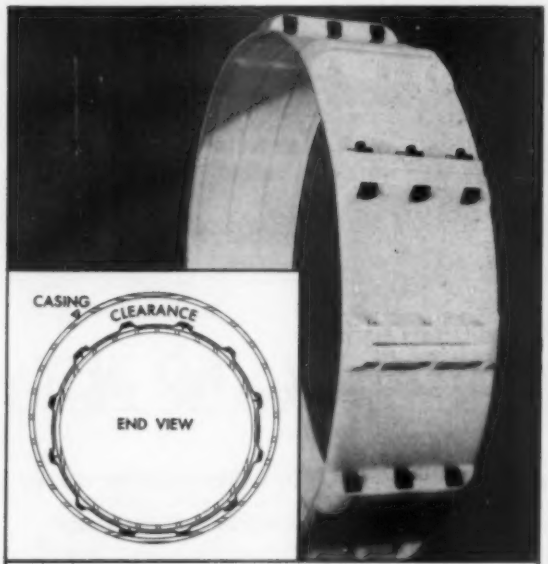
NEWS FROM DOWN THE LINE!

WmSON BIG-INCH M-2 THINSULATORS® MEET RUGGED TEST IN NEW JERSEY TURNPIKE CROSSING

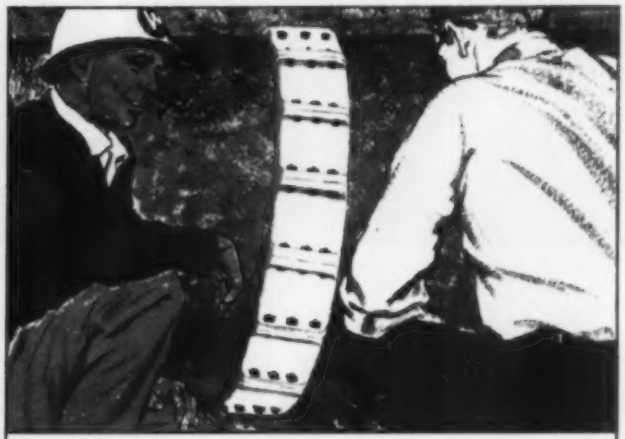
❶ "We'll pull the 36" drag section through this 275' casing. The casing has a slight dog-leg in the center which will make the pull a really tough test of the THINsulators."



❷ "M-2 THINsulators are high-density polyethylene products, resistant to fracture under tremendous impact. Most other plastic insulators are fiberglas reinforced polyesters that don't have the impact resistance, so breakage rates are high."



❸ "The high density polyethylene gives the M-2 such strength it can be made more compact than other insulators, allowing more clearance. It's flexible, so it conforms to the pipe for uniform coating loading . . . and the low coefficient of friction makes it slide like it's greased."



❹ "The tremendous force of the pull caused the lead THINsulator to absorb most of the shock. It twisted slightly but remained intact. All hands agree this is the best plastic casing insulation they have used."

❺ "Consider the economy of M-2 THINsulators. They cost no more than other plastic insulators, and breakage is **practically unknown.** Bend 'em, beat 'em, you can't break 'em."

T.D. Williamson, Inc.

P. O. BOX 40 • TULSA 2, OKLAHOMA

REPRESENTATIVES AROUND THE WORLD

Write Dept. B for Technical Bulletin on the M-2 THINsulator

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

TRANSWESTERN, newest of the major transcontinental gas pipelines, is equipped with UNIBOLT Scraper Traps, Blowdowns, and Closures for meter runs.

Unibolt—the original hinged scraper trap closure . . .

Still head and shoulders above the field!

Why are UNIBOLT Hinged Scraper Trap Closures first choice among so many pipeliners? (1) They are easier to open—only two bolts to release. No heavy lifting, nothing to fall on workmen. (2) They are the safest of all closures. The nut-lock must be released before the closure can be opened, and releasing the nut-lock automatically bleeds off any pressure that may be trapped in the line. (3) They swing open and shut on a sturdy hinge. (4) An oil-resistant rubber gasket provides a pressure-tight seal and seldom, if ever, needs replacement. Overtightening the closure bolts cannot damage the gasket.

The UNIBOLT Hinged Type Blowdown Closure for gas pipelines offers all of the unique advantages of the Scraper Trap Closure.

Complete details and specifications on these and other UNIBOLT products for the pipeliner are carried in Bulletin PL-590, a copy of which will be sent on request.

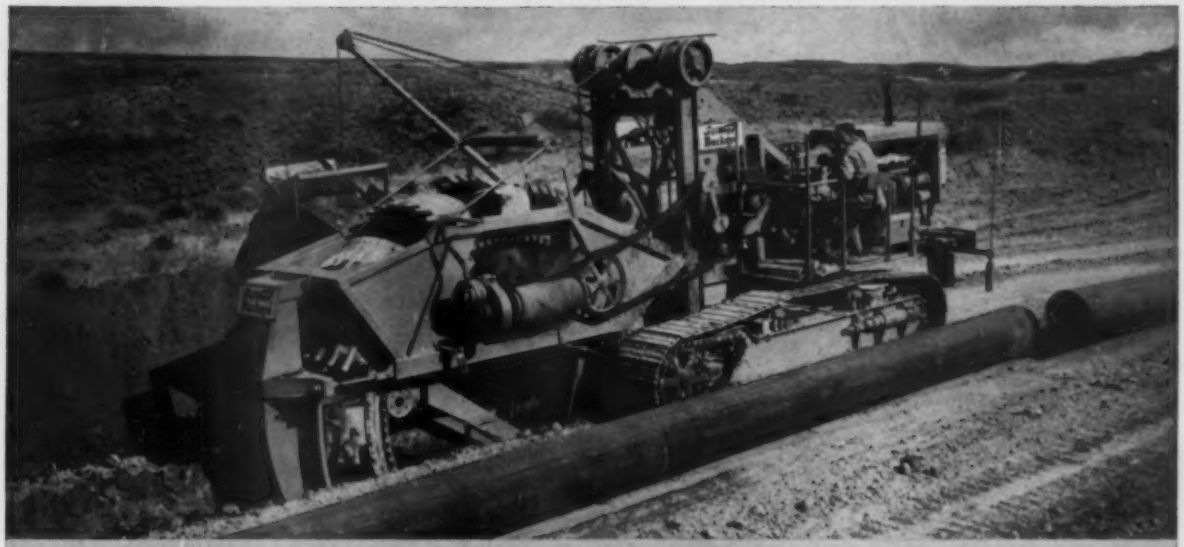
Unibolt Hinged Type Blowdown Closure for gas pipelines.

UNIBOLT

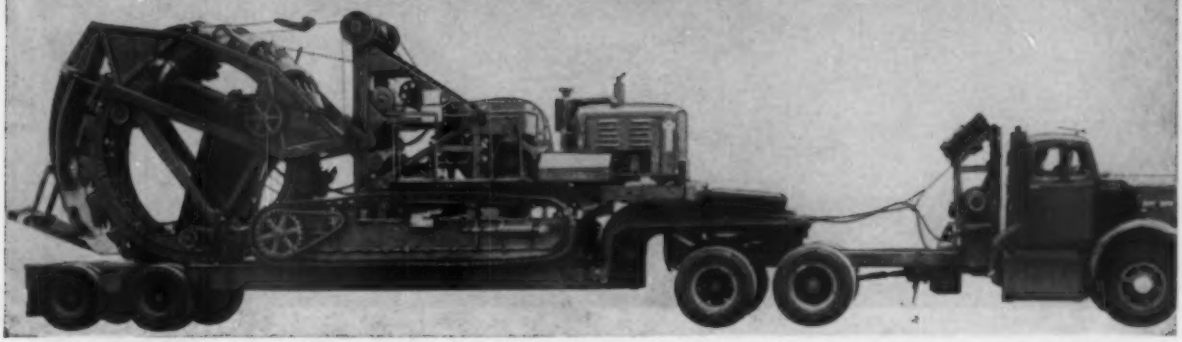
THORNHILL CRAVER CO.

P. O. Box 1184, Houston, Texas

NOW–A CROSS-COUNTRY PIPELINE DITCHER



THAT EASILY LOADS ON A LOW BOY



THE GAR WOOD-BUCKEYE 318 PIPELINER

No other large-capacity pipeline ditcher is so compact, so easily transported. No special rigs or downtime for dismantling are needed to transport the 318 – it loads *easily* on a standard low boy. The 318 has a high approach angle – a full 22° – plus a 32½" clearance under the engine with no "plumbing" to get in the way. And there's no dangerous weight shift, no danger of damage, because the 318's center of gravity is *ahead* of the rear crawler mounting axle.

Transportability is just one unusual feature of this big, fast pipeline ditcher. It's the *only* high-production ditcher equipped with a torque converter for *automatic* adjustment to work load. A tail shaft governor *automatically* maintains a constant output shaft speed. One-lever Hi-Lo Traction Shift increases traction speeds by 50%. Hydraulic wheel hoist and hydraulic conveyor drive are standard equipment.

These features mean efficiency–higher production, lower fuel costs, lower operating costs. One pipeliner reports he raised production by a third, cut fuel costs in half, and cut operating costs 15% –all by switching to the Gar Wood-Buckeye 318. It's the ditcher that's way out in front on *any* spread–and your Gar Wood-Buckeye dealer can show you why.

Gar Wood
INDUSTRIES, INC.
Findlay, Ohio • Wayne, Michigan

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Complete message center in one Teletype machine

A complete message center in a compact cabinet, with a choice of components to best meet your individual needs—that's the story of the Teletype Model 28 automatic send-receive set.

It provides facilities for sending and receiving on message paper or sprocket-fed business forms. In addition, there is a choice of four different tape reader and four different tape punch components—for preparing punched tape and for sending and receiving with tape.

The flexibility of the set is further broadened by a built-in control unit, the "stunt box," which may be equipped for a wide variety of extra features and switching duties—eliminating the need for external apparatus often required for such functions.

The ASR set is a compact, efficient tool to speed communications and cut costly paperwork. Teletype Corporation manufactures this equipment for the Bell System and others who require the finest in data communications equipment.

Typing Tape Punch

Tape Reader

Send-Receive Page Printer

Automatic Send-Receive Set

FREE Model 28 line folder. Write Dept. 92J. 5555 Touhy Avenue, Skokie, Illinois.

TELETYPE®
CORPORATION
SUBSIDIARY OF *Western Electric Company* INC.

See Teletype Corporation's equipment exhibit at the National Electronic Conference, October 10-12, Chicago, Illinois

Charles Rutter, Chief Corrosion Engineer for the Equitable Gas Co., and Carl Barclay, Koppers serviceman, examine Bitumastic pipeline coating.

"Experience is what really counts and Koppers servicemen have plenty of it"

That's what Charles Rutter, Chief Corrosion Engineer for Equitable Gas Company, had to say about the services of Carl Barclay, Koppers serviceman, after the completion of Equitable's Farmington, West Virginia 16" gas line.

Mr. Rutter added, "That man knows all the ins and outs of pipeline coating and construction. He was on the job with the survey team before it was started and he stayed until the very finish. When our men came up against a problem they couldn't solve, Carl Barclay had the answer. You can't beat having a Koppers specialist on hand who has worked on every kind of coating problem there is."

Equitable's new line runs from Lumberport to Farmington, W. Va., and is part of a general expansion of the utility's facilities to meet the growing demand from customers in Western Pennsylvania and Eastern Ohio. The entire line was coated with Bitumastic No. 2 Enamel after cleaning and priming. For Carl Barclay this was another opportunity to put his experience to work—experience that includes pipeline work in every state of the Union and Canada.

When you are planning an expansion of your current pipeline facilities, it will pay you to specify Bitumastic coal-tar enamels —as well as performance-proved products, you'll get experienced counsel from Koppers. For more information send the coupon or write: Koppers Company, Inc., Tar Products Division, Pittsburgh 19, Pennsylvania. District Offices: Boston, Chicago, Los Angeles, Pittsburgh, New York and Woodward (Birmingham) Alabama, and in Houston, the Mavor-Kelly Co. In Canada: Koppers Products, Ltd., Toronto, Ontario.

KOPPERS

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BITUMASTIC
COATINGS AND ENAMELS
another fine product of COAL TAR

Koppers Company, Inc., Tar Products Division
Dept. 105-J, Pittsburgh 19, Pa.
Gentlemen:
I would like a copy of your booklet on pipeline coatings, "How Long Should A Pipeline Last?"

Name_____ Title_____
Firm_____
Address_____
City_____ Zone____ State_____

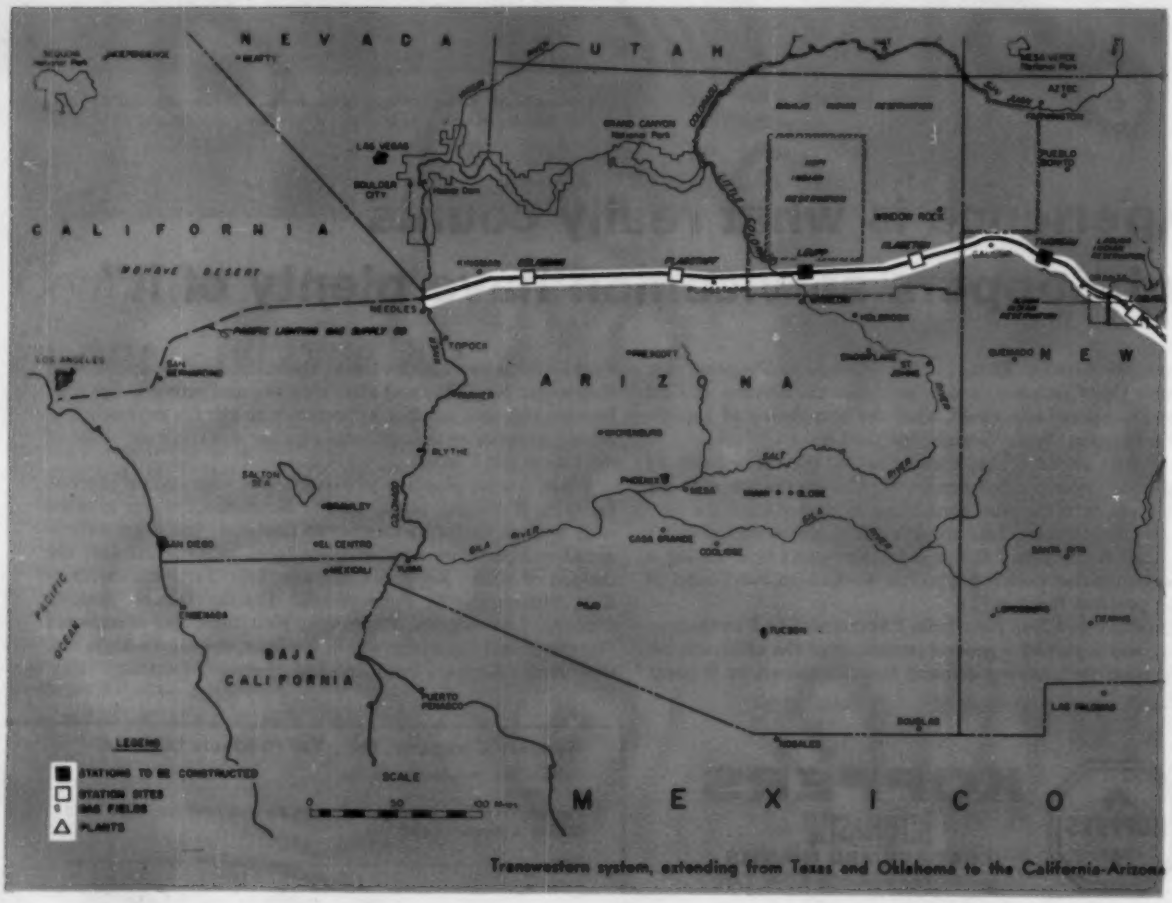
TRANSWESTERN GOES ALL-OUT

The 2013-mile system was

FRANK H. LOVE,
Editor

In building the major 1960 U. S. pipeline system Transwestern Pipeline Company has gone all out for automatic operation. As Transwestern moves through its early stages of operation, the system is being operated on a temporary manual basis. But, final pieces of control equipment are now being installed, tested, and placed in service, and when completed within the next few months, Transwestern will stand out in the industry as perhaps the most modern and efficient system in the world.

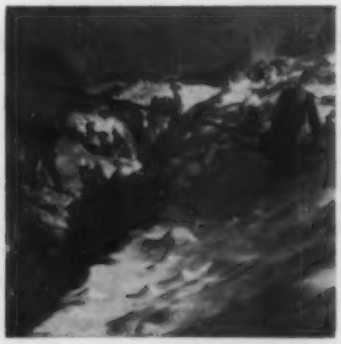
Many new concepts are found throughout: Automatic metering stations, automatic engine-driven centrifugal compressor stations, the first pipeline to use centrifugal compressors exclusively on the main line, the first to use X-56 grade pipe for its entire main line, as well as many other innovations.



Transwestern system, extending from Texas and Oklahoma to the California-Arizona

FOR AUTOMATION

completed on schedule despite . . .



. . . Snow

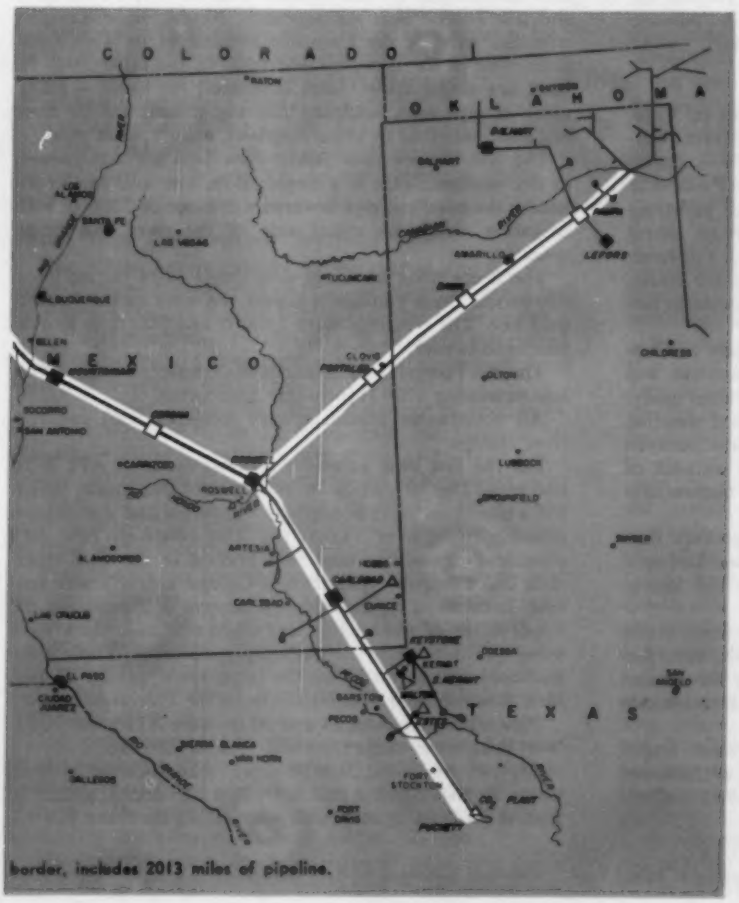
. . . Mud

. . . and Rock

In fact, almost every aspect of Transwestern's system has some unique feature worthy of mention.

Constructed for the purpose of providing more gas for the Southern California area, a seemingly insatiable energy market created by the tremendous population explosion of recent years, the new pipeline is taking Texas, New Mexico, and Oklahoma gas to the California-Arizona border and delivering it to Pacific Lighting Gas Supply Company at Needles. Distribution to consumers is being made by Southern California Gas Company and Southern Counties Gas Company, affiliates of Pacific Lighting.

Pacific Lighting has contracted with Transwestern for initial supplies amounting to 300,000,000 cu ft a day. This will be increased to



border, includes 2013 miles of pipeline.

Tariff Settled . . .
Transwestern On Stream

Although the Transwestern system was completed by July 26, first deliveries to Pacific Lighting were not made until August 9, the start being delayed awaiting FPC approval of the tariff. With the price of gas delivered at the California border set at 4.8 cents per Mcf, initial deliveries began at 50,000,000 cu ft a day. By September 1 the volume had increased to 200,000,000 cu ft, and by October 1 Transwestern will be delivering the contracted 300,000,000 cu ft a day.

350,000,000 cu ft not later than November 1, 1963, and Pacific Lighting will have first refusal of additional volumes up to 640,000,000 cu ft a day.

Transwestern had its beginning on March 11, 1957, when it was organized by Warren Petroleum Corporation of Tulsa, Oklahoma, J. R. Butler and Associates of Houston, Texas, and Monterey Oil Company of Los Angeles, California. Granting of a permit by the Federal Power Commission did not come until much later, however. On August 10, 1959, FPC issued a certificate of public convenience and necessity requiring that gas purchase prices be reduced, and by supplemental orders of September 23 and September 29, 1959, producers accepted the conditions of FPC, which allowed Transwestern to proceed with construction as its gas supply was then made firm.

Some contractors kicked-off their spreads late in November, others did not get underway until the early part of December.

Between the time of the company's formation and the granting of the FPC permit, gas purchase contracts were negotiated giving Transwestern developed and proved undeveloped gas reserves of 2.8 trillion cu ft of salable pipeline gas. In addition, gas purchase contracts covered more than 1,000,000 acres of undeveloped oil and gas leases.

Gas supply is from the Permian Basin area of West Texas and New Mexico and the Panhandle areas of Texas and Oklahoma. Moreover, as the main transmission line passes near the Four Corners area of New Mexico, Utah, Arizona, and Colorado, future additional supplies may come from this source.

To gather and deliver this gas, 2013 miles of pipe, 4 in. through 30 in., was laid and 35,000 hp installed at five main line compressor stations, plus two field stations. To take the gas, Pacific Lighting constructed a 117-mile, 34-in. pipeline from Newberry, California, to Needles, California.[1]

Route of the Pipeline

Transwestern's main line consists of 645 miles of 30-in. from Roswell, New Mexico, to the Arizona-California border. Feeding into the main line is a 288-mile, 24-in. northeast lateral originating at Canadian, Texas, in the Panhandle field, to which are connected other lateral and gathering lines varying in size from 4 to 16 in. A southeast lateral extends to the Puckett field, Pecos County, Texas, a distance of approximately 224 miles, of which 61 miles are 20-in., the rest 24-in. Laterals and gathering lines connected to this major lateral are sizes 4 in. through 12 in.

A part of the pipeline route is through extremely desolate country, especially in Arizona. Considerable mileage was laid through caliche soil, which could be ripped rather easily, but there also were many rocky areas where hard shooting had to be done. One of the toughest spots was between Kingman and Seligman, Arizona, where for a distance of about six miles the line passes through a series of narrow canyons that are all rock.

Another unusually difficult spot was at Sitgreaves Pass between Kingman and Needles, where the line was laid up a sheer rock cliff for a distance of one-half mile. This operation took 22 days of continuous shooting.

As construction began in the middle of the winter, crews had adverse weather conditions to contend with, nevertheless the project was completed on approximately the original target date. Some nine months and 12 days after acceptance of the FPC certificate.

Another report published in *Pipeline Engineer* (April 1960) discussed in detail many of the problems encountered and the construction methods that were employed. Following are highlights of this work.

[1] "Why Pacific Lighting Chose Bellhole Construction," Maurice E. Fuller, *Pipeline Engineer*, July 1960.

Construction began in mid-winter and heavy snows were encountered in the high altitudes of New Mexico and Arizona.

Construction Highlights

Four major river crossings were crossed during the course of construction, two of them twice. Two crossings were made of the Canadian on the lateral system in the Texas Panhandle, two of the Pecos in the Roswell, New Mexico, area, one each of the Rio Grande near Belen, New Mexico, and Rio Puerco near Albuquerque, New Mexico. Longest crossings were of the Canadian because of its wide flood plain. One of the crossings was 6120 ft, the other 5040 ft. Both are single 24-in. lines supported on bents — piling made of pipe sunk vertically into the ground and/or river bed and connected by cross members, made also of pipe.

The Rio Grande near Belen, New Mexico, was crossed in like manner. This is a single 30-in. line and header-to-header the overhead pipe covered a distance of 2200 ft. with irrigation canals on either side of the river also being spanned.

The Pecos River crossings were single 24-in. buried lines, one on the Texas Panhandle lateral, the other on the Puckett field line. The crossings were 2300 ft and 700 ft in length, header-to-header.

The Rio Puerco crossing also is underwater, a single 30-in. line measuring 1700 ft including approaches.

All underwater crossings were weighted with concrete river clamps.

For the first time extensive use was made of API X-56 line pipe. The 30 and 24-in. pipe was of this grade, which has a minimum yield strength of 56,000 psi and a minimum ultimate strength of 74,000 psi. This relatively new API classification was first used on a portion of the Gulf Interstate Gas Company system (now Columbia Gulf) with success. Because of its high carbon content it approaches the upper limits of weldability, and when first used there were some questions regarding welding procedures. These were answered satisfactorily by the experience gained at that time, however, and were borne out on the Transwestern job.[2]

Pipe other than sizes 24 and 30 in. were API grade X-52. Wall thicknesses range from 0.219 in. to 0.365 in.

Most of the 30 and 24-in. pipe was manufactured in 40-ft. joints. In New Mexico and Arizona it was double jointed in central yards set up at various points along the route, but this

[2] "Welding Techniques for X-56 Pipe," Norman Blundell, *Pipeline Engineer*, October 1959.

Welding equipment mounted on tractors solved the problem of mobility during muddy periods.

Many types of terrain were crossed . . . wagon drills speeded blasting when areas were extremely rocky.

could not be done in Texas because of legal restrictions on lengths that could be moved over highways. Some of the smaller diameter pipe was manufactured in 30-ft lengths and double jointed at the factory.

Coating and wrapping was with coal tar enamel, glass fiber, and kraft paper, field applied except for gathering lines and some laterals, which were yard coated. Application of coating was to a thickness of 3/32 in. Downstream from each compressor station, for a distance of 25 miles, hotline coating was used plus an asphalt-impregnated felt wrap. Elsewhere intermediate enamel was applied.

Spacing of main line valves was approximately every 17 miles, and testing was by sections between the valves, scrapers being run, and gas or water used to build up pressure.

Main Line Compressor Stations

The all-important muscles in the system are the unattended automatic compressor stations. The five main line compressor stations feature, for the first time in the industry, centrifugal compressors exclusively, as has been mentioned. The only reciprocating compressors on the system are small horsepower units in the laterals.

The ultimate number of main line stations planned is 14, of which nine will be on the 30-in. main line, three on the Panhandle 24-in. lateral, and two on the 24-in. West Texas lateral. At present only five stations have been built, four (stations No. 3, 5, 7, and 9) on the 30-in. main line and one (station WT-1) on the West Texas lateral. For location of these stations see the accompanying map.

Each station has two engine-driven centrifugal compressor units. Engines are 4-cycle, spark ignition, turbocharged units rated at 3500 hp at 327 rpm. The compressors are equipped with either a 29-in. or a 31-in. aerodynamic assembly, and are turned at a rated speed of 5500 rpm, being connected to the slower speed engines through two-stage high speed gears.

This compressor engine package is the improved version of the original package pioneered in 1956 on the former Gulf Interstate Gas Company (now Columbia Gulf Transmission). The improved version has a wider range of torsional-free operating speeds from 240 to 360 rpm.

Many modifications and improvements have been made on this engine since it was first introduced to pipeline service. The ignition and combustion air systems have been improved. A new mechanical coupling is used on the forward end drive mechanism, which is the power connection between the engine crankshaft and the auxiliary driveshaft that drives all engine auxiliary pumps. Also, a new low speed main drive hydraulic coupling is used instead of the standard flywheel. This coupling is on the input shaft to the speed increasing gear and is an integrated part of the overall torsional train. At the forward end of the engine a small step-down gear drives the aerial cooling tower fan from the engine crankshaft through a hydraulic drive.

The speed increasing gear is of the two-stage, double helical, separate helix, articulated type, rated at 5000 continuous horsepower at a maximum output speed of 6055 rpm. Normal maximum operating speed of the engine is 360 rpm. Thus, the gear ratio is 16.819:1. The gear set consists of a low speed gear, an intermediate pinion, an intermediate gear, and a high speed gear, all enclosed in a leak-proof welded steel case. The output high speed shaft is connected to the centrifugal compressor through a high speed coupling.

Building construction. The engine and gear set are situated inside a 50-ft by 56-ft fireproof concrete building. All load carrying building columns were poured in place, as was the 12-in. firewall that separates the main and auxiliary buildings from the compressors and the high pressure gas piping in the yard. The long high speed coupling that connects the gear with the compressor actually passes through the firewall. This wall is designed to take an assumed explosion pressure of 100 lb per sq ft and a co-existing wind load of 25 lb per sq ft.

The engine room and adjoining auxiliary room are enclosed with precast concrete wall panels that are bolted to the building columns. The precast wall panels are finished in an attractive white architectural style.

The building roof is composed of prestressed concrete girders supporting precast roof channels and the built-up roof. There are four of the large prestressed girders, two of which are 50 ft long by 36 in. deep. The other two girders are 34 ft long and 27 in. deep. With full live loads a maximum deflection of 1/16 in. is expected. When cast these girders had a camber of approximately ⅜ in.

Precast roof channels have angle iron imbedded at each end and are welded to plates embedded in the top flanges of the girders. Additional steel angles were embedded in the

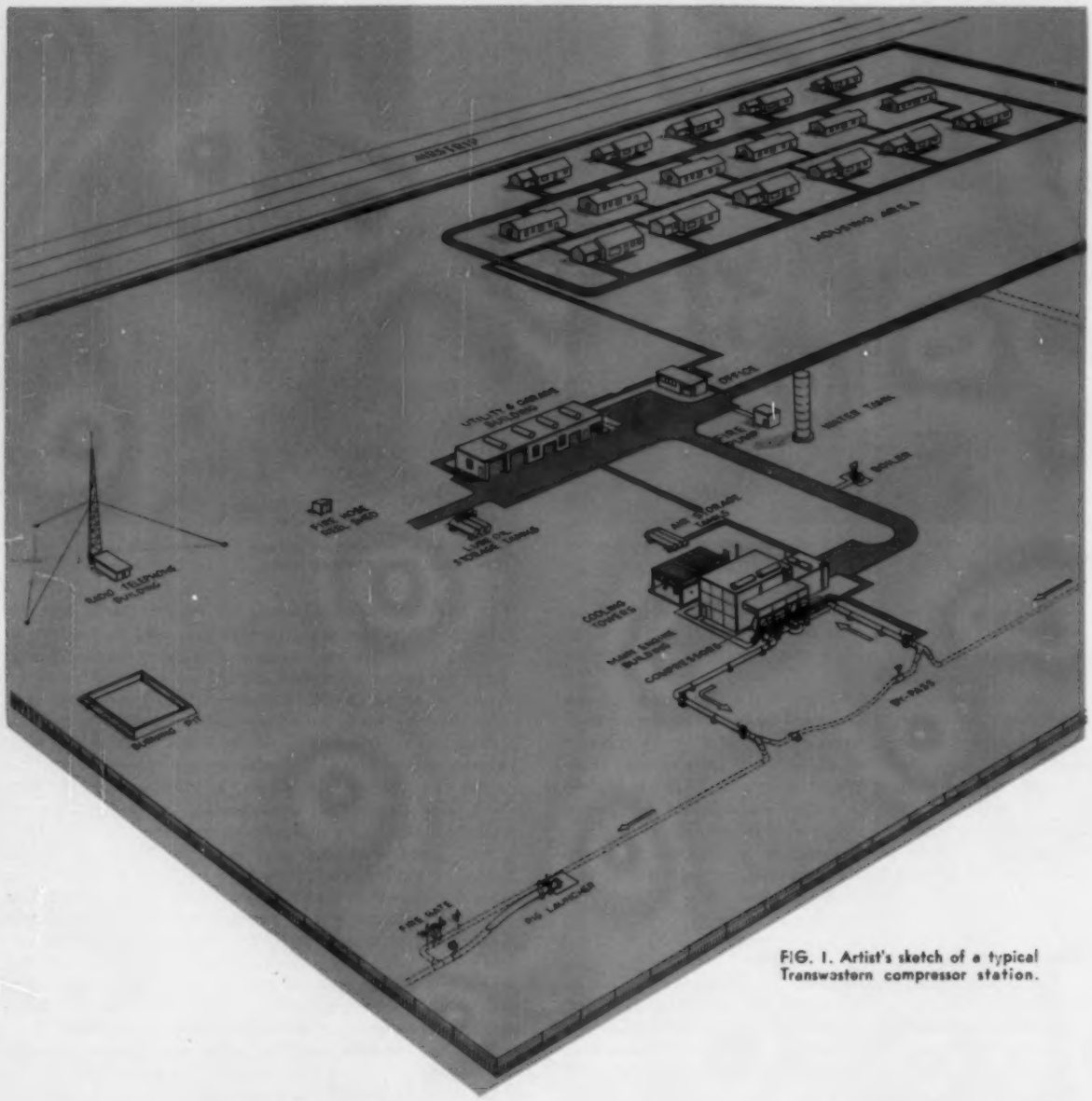


FIG. 1. Artist's sketch of a typical Transwestern compressor station.

roof channels so that they are welded to each other as they set side-by-side. Thus, the entire roof system is firmly tied together and acts as a unit, providing the required lateral stiffness between the girders.

This building construction is quite similar to that first used in the centrifugal stations on the Columbia Gulf line in 1957. A major improvement, however, is the auxiliary room that adjoins the main engine room. This 34 by 40-ft room houses not only the station control panels, but also two engine generator sets, starting air compressors, small emergency engine generator sets, motor control panels, a bank of emergency storage batteries, and certain other equipment necessary to the operation of the compressor station.

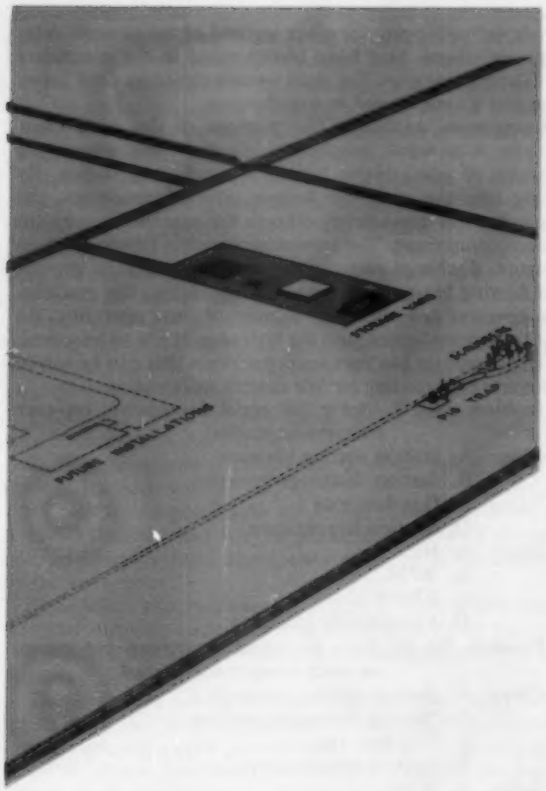
Related service facilities, such as locker rooms, machine shop, store rooms, and garage are housed under one roof in what is called the utility building, situated some distance from the main engine room.

A third building provides office space for the station supervisory and clerical personnel. This building, as well as the utility building, are of clay tile construction.

The office building is fully air-conditioned. Main engine and auxiliary buildings have a pressurized air-ventilating system. Pressure blowers and automatic roof ventilators are oversized to provide more than the minimum required air changes per minute. This type system is designed to prevent blowing dust and sand, so prevalent in the western parts of the country, from contaminating the interior of buildings. The system will hold a pressure of ¼ in. of water pressure inside the building at all times, and with adequate filtering of the outside air as it enters the pressure blowers, will keep the rooms free of dust and sand.

A new type oilbath filter purifies combustion air for the engines. This filter, air-intake silencer, and discharge muffler, are mounted on the side of the engine room that faces the aerial cooling tower. An alleyway between the cooling tower and the engine room gives adequate space for the air equipment and various cooling water pipes that project from the engine room over to the cooling tower and its headers.

Inside the building the service piping has been placed in trenches, along with piping for the engines and gear oil heat



exchangers and filters. The trenches are covered with strong floor grating, which forms the main floor for the building. The result is unusually clear floor space around the engines and throughout the building.

Inside walls of the building have a slick clay tile surface that extends up the wall for some 6 ft to facilitate cleaning. The rest of the wall is the back surface of the precast wall panels. These surfaces have a simple broom finish, the same as that on the interior surfaces of the roof channels and girders.

The interior of the engine and auxiliary building are unusually well lighted with a new type of mercury vapor lamp. Actually, the lamps are a combination of incandescent-mercury light that removes the big objection to the use of the well-known mercury light, which requires a cooling off period when the lamp is turned off. This re-starting delay is quite objectionable. In contrast, the incandescent elements of the new type lamp will immediately give off light until the mercury vapor part of the lamp re-starts. Ten of these lamps are situated around each compressor unit, providing 26 foot-candles per square foot of floor area. Light in the upper part of the building is provided sufficiently by a row of windows around the top of the building walls.

One of the more attractive points of interest in and around the compressor stations is the color effect created by the paint coding system that identifies the various parts of the piping system. Color coding plus the white finish on the precast concrete wall panels presents a most attractive compressor station.

Piping arrangement. The gas piping arrangement for Transwestern's main line stations has been designed so that all high pressure piping (as well as the centrifugal compressors) is located outdoors and separated from the main engine and auxiliary building by the 12-in. poured-in-place concrete firewall. Compressors are placed adjacent to the firewall under a precast concrete roof extension. All gas piping is aboveground, which will facilitate inspection, painting, and repair work.

Also, particular attention has been given to making the yard gas piping and the main building expandable. All valves are of the welded-in type. Three sets of flanges are used on the discharge side of the No. 2 compressor to provide an easy means of expanding the gas piping to allow for a maximum of five compressor units in this one area. Similarly, one side of the main building (opposite the auxiliary room) is removable for expansion purposes.

Two specially designed heavy mechanical filters are welded into the suction gas piping to remove bits of debris that may be present in the gas stream and prevent harm to the centrifugal compressors. One filter is located in the suction piping to each compressor.

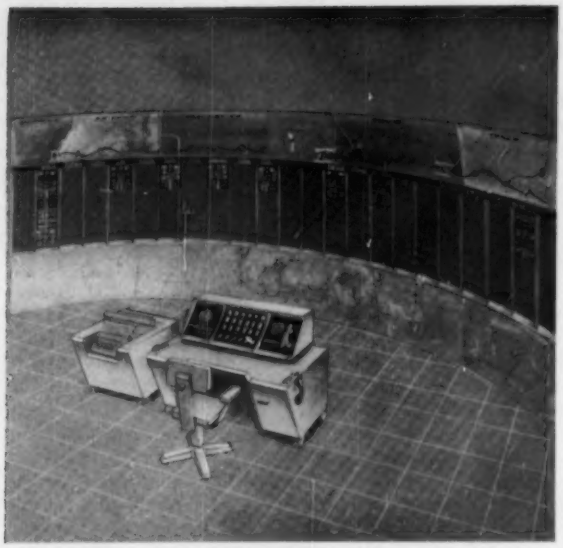
Fig. 1 is an artist's sketch showing the layout of a typical Transwestern main line compressor station, typical except for the number of houses at each station. Whenever possible personnel are living off the station property; however, the extreme remoteness through which the pipeline passes made it necessary to provide adequate housing facilities at some station sites for all station and pipeline personnel.

Station Spacing Unusual

One of the interesting features of the Transwestern pipeline design is the spacing of the stations and the method by which Gulf Interstate arrived at this spacing, taking into account the difference in elevation between the stations. The most simple method for calculating elevation correction is to assume a constant slope between the points and using the fluid density to calculate the difference in head. The head difference is then divided in half. One part is applied to the pressure into the section (P_1) and the other is applied to the pressure leaving the section (P_2). This method would work satisfactorily if the pipeline had a constant slope between stations. This is not the case with Transwestern's pipeline. The pipeline changes slope many times in each section, so in order to retain the desired accuracy, the entire line would have to be broken into relatively small sections of equal slope and a head difference calculated for each. This would be very unsatisfactory for Transwestern's application because of the many slope changes between stations.

A more refined method was decided upon that offers both ease of calculation and results of suitable accuracy.

The total elevation correction for each section is composed of two parts: An equivalent length and a constant factor to correct the final pressure. The values of equivalent length (L_T) are determined for each section of the pipeline by breaking it into lengths of equal slope and then multiplying each length by a head factor. The partial equivalent lengths in each section are then added to arrive at the equivalent length for the entire section. The equivalent lengths calculation need be made only once for each flowing temperature and gravity.



Artist's sketch of the dispatcher's control board in Roswell control center. To alter the pipeline pressure or flow, the dispatcher merely pushes the proper button to initiate a chain of orders to the various controlled points. As his orders are automatically executed, data is telemetered back to Roswell and displayed on the board. The dispatcher is constantly advised of the operating conditions on the pipeline by the data displayed on the board.

The factor to correct the final pressure (P_2) is calculated in the form e^s where:

$$s = \frac{Z\ H}{ZRT}$$

H — Elevation difference between stations, ft.
Z — Compressibility factor for the gas at flowing temperature and average pressure.
R — Gas constant.
T — Flowing temperature, R°.

The Panhandle equation is then expressed as:

$$Q = K \left[\frac{P_1^2 - e^s P_2^2}{L_T} \right] 0.5394$$

System Control Center

Heart of this automatic pipeline is the control center at Roswell, New Mexico. This is the logical location for the operating nerve center, for at that point it is astride the all-important junction of the 30-in. main line with the 24-in. Panhandle and West Texas laterals.

From the control room the dispatcher will be able to control the entire system extending from the California-Arizona border, across Arizona, New Mexico, and on into the two Texas gathering systems. System controls will be housed in a 10,000 sq ft office and control building soon to be completed.

Dispatching the mountainous Transwestern system will not be materially different from that of other pipelines in similar terrain. It has, however, been simplified. The dispatcher has at his disposal a number of important dispatching aids. Two of the more important are the computers, specifically designed to meet the dispatching requirements of the Transwestern system. One computer is designed to handle flow problems, the other centrifugal compressor problems. Each is tailored to the exact Transwestern problems and for this reason a third computer, universal in nature, has been provided for more general flow problems, not specifically Transwestern's.

The computers are mounted in one console cabinet with the "compressor analyzer" on the extreme right of the cabinet, the "pipeline simulator" and the "Universal pipeline simulator" occupying the other sections of the console. Adequate provisions have been incorporated in the computers for future expansion. The units were designed by Gulf Interstate and manufactured to specification.

Compressor analyzer. The purpose of the compressor analyzer is to solve complicated equations that govern the behavior of compressors within a compressor station. By setting into the computer known external conditions, the dispatcher can immediately observe the operating conditions of each compressor. The known information (station suction pressure, discharge pressure, flow quantity, specific gravity, and flowing temperature) can be dialed into the machine. The operator can select the number of units operating, the unit to be investigated, and the type of problem to be solved.

The computer has four basic problems that can be solved automatically, reading out the desired information:

Problem No. 1. Solve for equal horsepower on each compressor studied.
Given: A. Station suction pressure
B. Station discharge pressure
C. Gas flow rate
D. Suction temperature
Solve: A. HP
B. RPM
C. BMEP
D. Compressor efficiency

Problem No. 2. Solve for equal revolutions per minute on each compressor studied.
Given: A. Station suction pressure
B. Station discharge pressure
C. Gas flow rate
D. Suction temperature
Solve: A. RPM
B. BMEP
C. HP
D. Compressor efficiency

Problem No. 3. Solve for equal brake mean effective pressure on each compressor studied.
Given: A. Station suction pressure
B. Station discharge pressure
C. Gas flow rate
D. Suction temperature
Solve: A. BMEP
B. HP
C. RPM
D. Compressor efficiency

Problem No. 4. Solve for actual operating conditions.
Given: A. Station suction pressure
B. Station discharge pressure
C. Gas flow rate
D. Suction temperature
E. Engine governor setting
Solve: A. HP
B. RPM
C. BMEP
D. Compressor efficiency

It is possible to solve other problems by having the machine in one of the various problem positions and varying an input value until a desired computed value is indicated. The computed values of BHP, BMEP, RPM, discharge pressure, and compressor efficiency are read from ammeters inscribed with the appropriate units.

Magnetic amplifiers and silicon diodes constitute most of the components; no vacuum tubes are used. This results in a unit virtually maintenance free and one that has a comparatively low power consumption. The computer can operate with broad fluctuations in voltage and still maintain the design accuracy.

Pipeline simulator. This computer simulates the physical characteristics of the pipeline electronically. It is divided into four sections: Main Line, West Texas Lateral, Pan-

handle Lateral, and Universal. All mounted in one console cabinet, the Main Line, West Texas Lateral, and Panhandle Lateral simulators contain the normal data relative to each section (line length, elevation corrections, and pipe size). The Universal section is completely general and permits solving a wide range of special problems not necessarily associated with the present pipeline.

Each section consists of a Panhandle equation computer, horsepower computer, memory mechanisms, and means for switching the units into appropriate circuits for automatically computing the flow on the pipeline. The operator must program the computer for the type of problem to be solved and insert the known data into the machine.

Selectors are provided to choose which of the four direct problems are to be put into the computer. The following does not contain all possible problems, but indicates the general kind that can be solved:

1. Normal operating conditions where discharge pressure is inserted for each station.
2. Normal operating conditions in which horsepower is inserted for each station.
3. Solution of conditions for which a known flow rate, terminal pressure and suction pressure at Roswell station, will produce the same horsepower required at all stations on the main line.
4. Solution of conditions for which a known flow rate, terminal pressure and suction pressure at Roswell station, will produce maximum permissible discharge pressure at all stations.

The computer solves the problems in a set order and works from station to station. Limits for discharge pressure and compression ratio are automatically inserted into the machine. Horsepower limit is inserted by dials in the front panel. If, in the course of a solution, a limit condition is exceeded, an alarm light will inform the operator which condition is outside of the limits and where it occurs. The operator can then make the necessary adjustments to arrive at a workable solution.

Each Panhandle equation computer takes into account suction pressure, discharge pressure, flowing temperature, specific gravity, line efficiency, line length, elevation correction, flow rate, and pipe diameter when solving for the desired information.

An important function of the Panhandle equation computer is elevation correction, the purpose of which is to account for pressure differential due to the column of fluid between any two points to be examined. Specific application, of course, is calculation of pressure drop between compressor stations.

Analog computers for the Roswell control center are important dispatching aids. Three different computers are housed in this console. The centrifugal compressor-engine analyzer is at the extreme right of the console. A universal pipeline simulator is in the next section. The next three sections to the left house the pipeline simulator specifically designed to fit the Transwestern Pipeline system. The middle computer simulates the West Texas lateral and to the left of it is the Panhandle lateral computer. The main line computer is housed in the extreme left section of the console. Data from the computers can be read out in digital form or logged on the electric typewriter.

A new concept is the automatic engine-driven centrifugal compressor stations. This area of the main engine room shows a portion of an engine on the right. Back of the engine is the gear speed increaser that connects it to the centrifugal compressor. The automatic electro-pneumatic engine control board and the mercoid panel are to the left of the gear. Windows and wall to the left separate the auxiliary room from the main engine room. Station and engine centralized transportation control (CTC) equipment are installed just beyond this wall, but are not visible. The wall behind the engine control board is a 12-in. poured firewall that separates the engine from the centrifugal compressors.

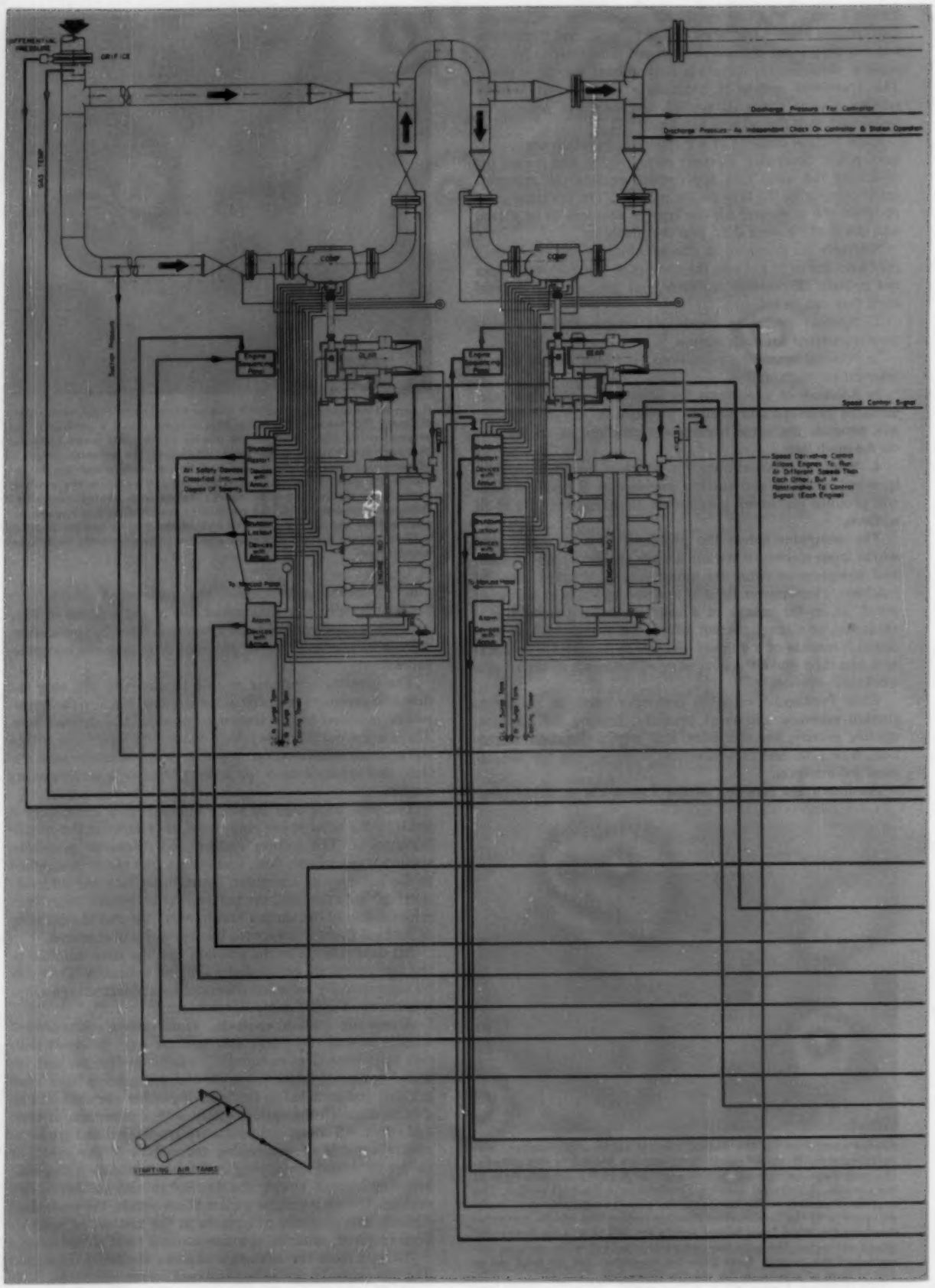
The pipeline computer is able to compute not only the flow and pressures required at the stations, but also the horsepower required at the station to produce the desired flow. There are separate horsepower computers integrated within the pipeline simulator, one for each installed compressor station, and separate ones for a centrifugal or a reciprocating station.

The data computed by the Panhandle flow computers is fed into the horsepower computers, to determine the station horsepower. The station suction and discharge pressures, suction temperature, flow, and even a fuel factor is supplied to the horsepower computer. From these data and information built into the unit, the horsepower computer then determines not only the station horsepower, but also the quantity of fuel gas that the computed horsepower will consume.

All data relative to the solution and the data supplied to the computers are read out on a digital voltmeter. Data can be automatically recorded if desired by an electric typewriter incorporated in the computer console.

Automatic station controls. Transwestern's unattended automatic remotely controlled stations were designed with two main objectives in mind . . . reliable operations and reduced operating costs. Controls and instruments have been selected and installed so that one dispatcher per shift will be able to dispatch the system safely with a minimum of time and effort. All controlled points are unattended and are completely capable of controlling themselves in the event of failure or a fault developing in the communication and telemetering circuits linking the dispatcher with the controlled stations. If such a temporary condition occurs, the controlled stations will continue to operate at the last set of instructions received, until the communications fault is corrected.

All data from the automatic stations are being channeled into this central point to be displayed on the giant 9 by 23-ft


Discharge Pressure For Controller
Discharge Pressure - As Independent Check On Controller & Station Operation
Speed Control Signal
Speed Operative Control Allows Engines To Run At Different Speeds Than Each Other, But In Synchronism To Control Signal (Each Engine)
STARTING AIR TANKS

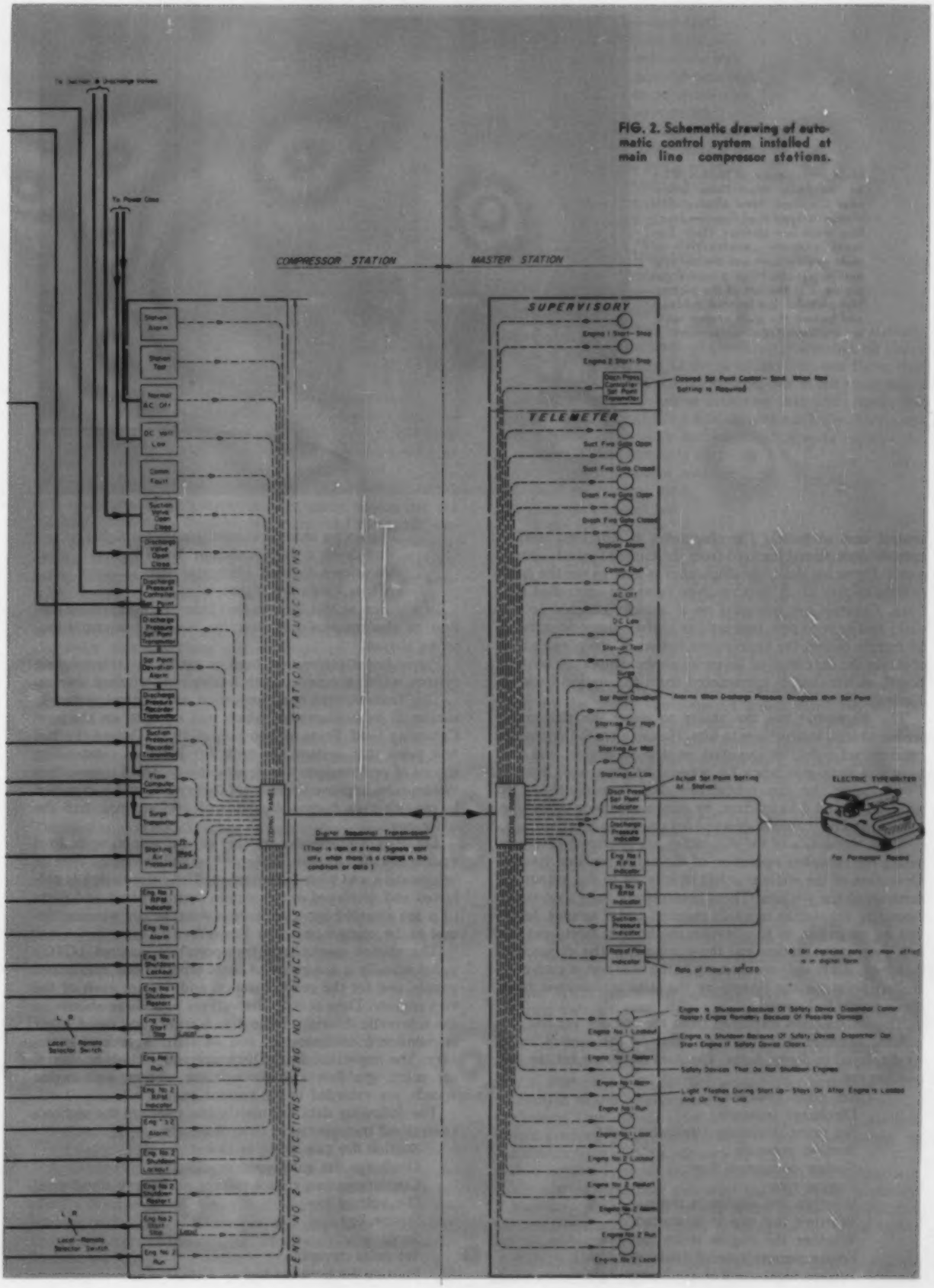
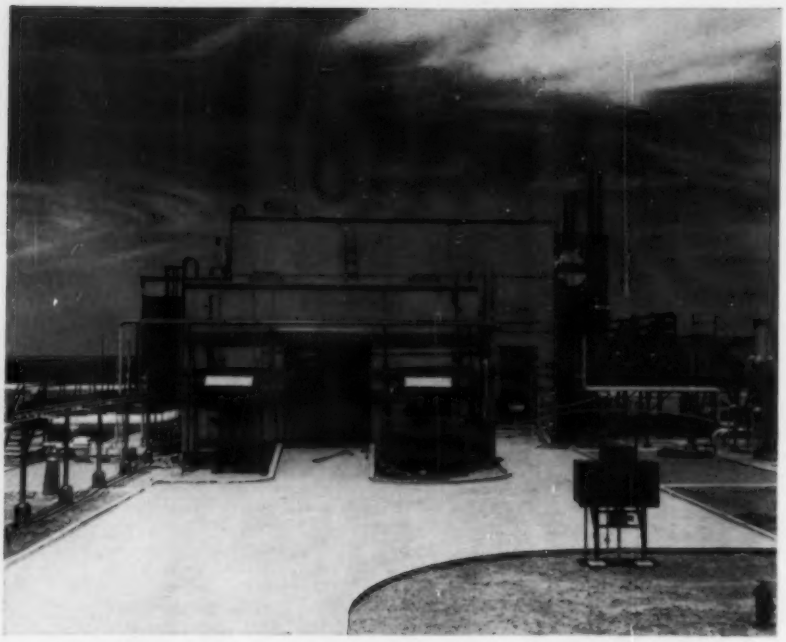


FIG. 2. Schematic drawing of automatic control system installed at main line compressor stations.



Main engine room at Station WT-1 on the 24-in. West Texas lateral near Carlsbad, New Mexico. This station is typical of Transwestern's four main line stations. Note fireproof concrete construction of main engine room and the low roof auxiliary room. High pressure gas piping is at the left of the picture. Not pictured, but located outdoors and behind the main engine room, are the centrifugal compressors.

central control panel. The dispatcher is provided with a console desk placed forward from the curved central control panel. From his desk, the dispatcher is able to see the panoramic display of all data received from the controlled stations. Controls are mounted on a console attached to his desk, and to send new instructions to the automatic stations he merely pushes the appropriate button on the console and observes the execution of his order on the panoramic control board, as the data is telemetered from the station back to Roswell.

The dispatcher has the ability to select the station he wishes to send instructions to him. He can alter the discharge pressure set point, he can start or stop an engine, and can have this data sent when he presses the data send button. Furthermore, he can cancel this data immediately after sending, should it be in error, by means of a code cancelling button, and he is able to demand data recall as he chooses.

Thus, the duties of the dispatcher are restricted to supervising the complete operation of the entire pipeline system. Operation of the stations is left strictly up to the automatic controls at the stations. These controls are fully capable of operating the station in a safe manner, and if trouble develops on an engine or to a station the built-in safety devices will protect the station and the equipment. The dispatcher, however, is advised continuously of the situation at each controlled point on the system by the data transmitted from those points to Roswell.

The information displayed from the stations for the dispatcher is either indicated with lights on the control board or displayed in digital form. The data displayed for the dispatcher are:

Set point position
Discharge pressure
Set point deviation (indicator light)
Suction pressure
Station computed flow
Engine rpm
Whether the engine is down
Whether the engine is started
Whether the engine is on the line
Engine remote control (indicator light)
Engine local control (indicator light)
Engine on manual control (indicator light)
Shut-down restart (indicator light)
Shut-down lockout (indicator light)
Alarm (indicator light)

In addition to this information from the compressor station, he also receives data from the Needles automatic metering station.

Particular attention has been given to the telemetering system, which is coupled with a telephone wireline service.

The Transwestern communication and control system is similar to its predecessor, which was installed on the now Columbia Gulf Transmission line in 1957. During the last few years that system has built for itself an outstanding record of performance and dependability. The Transwestern system is an improved version of that system and is expected to provide even higher standards of performance than the older one.

Fig. 2 is a schematic drawing of the automatic control system installed at main line stations, and shows the type of information and where it is sensed. This information is collected and displayed at the station control panel and parts of it are encoded for transmission over the d-c wireline circuit to the control center in Roswell.

The station centralized transportation control (CTC) panel actually is composed of three separate but interlocked panels, one for the general station and one for each of the two engines. Data sent to the various panels are shown on the schematic drawing. Some data is merely indicated, other is monitored continuously, and an alarm sounds if necessary. The important data: Discharge and suction pressures, set point, gas flow rate through the station, and engine speeds, are recorded in the various panels.

The following data are merely indicated on the station's centralized transportation control panels:

Suction fire gate, open or closed
Discharge fire gate, open or closed
Communication circuit voltage on battery standby
D-c voltage low
Station test
Surge
Set point deviation
Starting air pressure high

Starting air pressure medium
Starting air pressure low.

The quantity of gas passing through the station is computed continuously by a flow computer mounted in the CTC panel. An A.G.A. large diameter orifice meter run is integrated within the suction gas piping to the No. 1 compressor, and data from this meter are fed continuously into the flow computer.

Prime controlling instrument at the stations is the discharge pressure controller. This is an electronic recorder-controller with a digital input set point servo. The discharge pressure controller index servo was designed to record the set point positional data as received from the dispatcher, and to drive to the set point dictated by the dispatcher. At the new set point, the instrument then transmits its new position to the dispatcher in digital form. The controller measures the discharge pressure and senses any deviation of that pressure from the set point. If a deviation is detected by the controller, it sends out a pneumatic signal to each engine to raise or lower the engine speed, thereby correcting the pressure deviation. Volume control at the stations is achieved by controlling the engine speed.

It took considerable time and engineering to select the proper sized aerodynamic assembly for the centrifugal compressors so that the simple engine speed control would be effective in achieving the desired volume control.

Safety controls override. Of paramount importance to the safe operation of an automatic compressor station are the vital safety features. In a properly designed automatic station the safety controls must be completely interwoven around the operating controls and so interlocked that the safety features have the ability to override the other controls. Such is the design of the control system for Transwestern stations. In general, these safety devices are grouped under three classifications: Alarm, shutdown restart, and shutdown lockout. These classifications apply not only to the engine controls but to the station as a whole. Transwestern automatic control equipment is designed so that engine functions are carefully interlocked with station functions to fully protect the station in any situation.

The engine panel with its sequence equipment is designed for complete sequence startup, continuous operation, and complete sequence shutdown. Within the sequence startup and shutdown, the systems are interlocked such that should a malfunction occur the engine will shut itself down. The shutdown is displayed on an annunciator panel for that particular engine, thereby isolating the malfunction that caused the shutdown. The annunciator is so designed that only the first or original function that caused the shutdown will be displayed on the annunciator panel.

The more important functions will result in a shutdown-lockout situation. Thus, station personnel must correct the malfunction and reset the controls or sequencing equipment before the unit can be restarted. The shutdown-lockout functions are:

Fan vibration
Engine vibration
Gear vibration
Compressor vibration
Gas piping vibration
Engine oil pressure vibration
Turbo oil pressure low
Gear oil pressure low
Engine crankcase pressure high.

A number of possible malfunctions will result in a shutdown but will allow the equipment to be restarted. Quite often a function may correct itself during shutdown or restarting of the engine. Therefore, the dispatcher is allowed an attempt to restart the engine. The functions in this classification are:

Engine valve position false
Engine oil pressure high
Gear oil pressure high
Engine oil temperature high
Jacket water temperature high
Starting air temperature high
Gear oil temperature high
Compressor case temperature high
Compressor thrust bearing high
Discharge gas pressure high
Compressor seal leakage
Seal oil accumulation tank level high
Seal oil accumulation tank level low
Seal oil tank level high
Seal oil tank level low
Engine oil level high
Engine overspeed
Engine detonation.

The third classification of safety devices are continuously monitored, and if an unusual condition is detected, an alarm is sounded. Generally, these functions are not those that initially would shutdown the engine, but if left unattended they will result in a serious condition that will require the unit to shutdown, which it will do automatically. Thus, station personnel normally has sufficient time to correct the condition. These functions are:

Seal oil differential pressure high
Seal oil warning level
Engine oil level low
Gear oil level low
Jacket water surge tank level low
Oil cooler water surge tank level low.

Also provided are a number of safety devices that monitor the timers in the sequence startup or shutdown. Should any phase of these sequences take longer than the predetermined time, these devices come into play and the unit will shut itself down. When this happens a starting sequence fault annunciator tab will be displayed, identifying the malfunction as being the starting sequence.

In all the above functions an annunciator tab will be displayed in the annunciator and an alarm will be sounded throughout the station to alert station personnel.

The station centralized transportation control panel has a number of safety features incorporated within it that will shutdown the station and render all equipment in a safe condition, including closing the fire gate and the fire doors of the engine and auxiliary buildings. These conditions are:

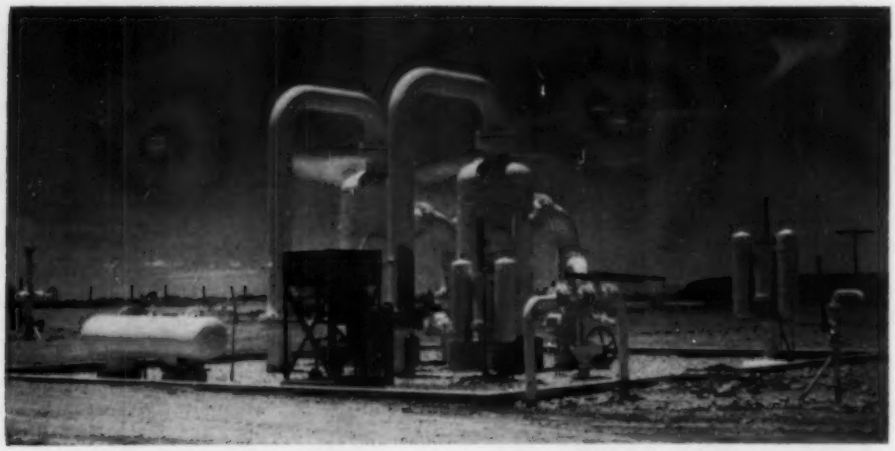
Discharge gas temperature high
Suction pressure low
Pipeline break
Explosive gas mixture within the engine building.

Should a fire exist in the auxiliary or engine rooms, or within the compressor area, the station would be shutdown and rendered safe. The engine would shut down, as would the electrical generating equipment, all fire doors and ventilators in the main and auxiliary room would close, the fire gate valves would close, and the yard piping would be blown down.

In the event of a fire the fire pump engine would start directing water to the sprinkling system in the main building, if that is where the fire exists. The carbon dioxide equipment would be energized if the fire were in the auxiliary room. One minute prior to shutting down the electric power generating equipment a flag would be displayed on the annunciator and the alarm sounded.

A number of points are located around the station site where station personnel can start the fire pump manually if necessary. Water from the fire pump can be directed into the residential area, the utility building, or the office building, as required.

A fully integrated remotely controlled emergency shutdown system has been installed. A number of the emergency



Typical gas scrubber setting at stations. These dry type scrubbers are designed to clean 200,000,000 cu ft a day each. Note control cabinet. This unit tests the action of the automatic valve operator on the station fire gate, in service. The small tank to the left is the power gas supply for the automatic valve operations. Stub-ups are provided for a third scrubber to be added in the future.

shutdowns are situated at strategic points around the station. Activation of the system from any of these remote stations will result in the engines and other equipment shutting down in a safe condition. The yard piping would blow down after the fire gates closed. Fire doors and ventilators would close automatically so that the station would be placed in a completely safe condition.

A gas analyzer is on guard constantly inside the engine room. Should a level greater than 40% of the lower explosive level be sensed or detected within the engine or auxiliary room, the ventilating fans would be energized, the vents would open automatically, and an attempt would be made to dilute the gas concentration. Should the gas concentration continue to increase, and exceed 60% of the lower explosive level, then the station would be automatically shutdown and placed in a safe condition.

Electric-pneumatic sequencing. All automatic sequencing equipment is either operated by d-c voltage or it is pneumatic operated. Thus, the system is classed as an electro-pneumatic system. The electrical part is so designed that in event of generator power failure, emergency generators will be started to supply power to the control equipment as before, with no interruption to the controlled operation of the gas pumping equipment. Should the emergency generator fail at the same time, standby batteries are provided that will supply sufficient power for at least eight hours of continued automatic operation before it is mandatory that the station be placed on manual operation.

The control system and electrical generator equipment are designed so that trouble can be easily detected and quickly remedied, keeping the compressor equipment on the line at all times.

The starting air system likewise is designed for a minimum of eight hours standby. This, of course, precludes the starting and stopping of a group of engines within that time. The electro-pneumatic control system has proved, in the past, that when the electrical storage energy is depleted, all equipment can be successfully operated manually, using the pneumatic control system for each engine.

Needles Measuring Station is Automatic

Gas is delivered to Pacific Lighting Gas Supply Company through the Needles measuring station, which automatically controls and computes the flow of gas through the meter runs. Seven 10-in. orifice meter runs have been installed at the station and provisions made for five additional tubes to be installed in the future. A total of 24 10-in. tubes is anticipated when Transwestern reaches the ultimate flow for a looped 30-in line. There are two clay tile buildings at this station, one for the office and control equipment, the other housing the orifice meters.

The station was designed for either automatic or manual operation and can be controlled remotely by the dispatcher at Roswell or locally by the station personnel. Heart of the control system is composed of three main components: (1) Flow computer, (2) flow controller, and (3) flow control valve. The vital telemetering system links these components together at the station and connects Roswell control center with the station.

The flow computer determines the gas flow through the station continuously. It has an accuracy of 0.1% of full scale flow, or an equivalent accuracy of 1000 cu ft per day. It receives inputs of static and differential pressure, flowing temperature, all from one meter run, and the total number of runs in service.

In addition to this information, the computer receives one other input, which is adjustable and adds those necessary orifice factors that must be used to compute the flow through an orifice as required by the Standard AGA Orifice Flow Equation. The adjustable input in an equivalent factor for the size of orifice, specific gravity, pressure and temperature bases, etc. If these factors change, the adjustable constant input to the computer can be altered to correct the flow computation.

The output signal of the computer is fed into the flow controller, whose job is to maintain a constant rate of flow through the station. The unit is equipped with a motorized index to allow local or remote setting to the desired flow rate. The instrument is equipped with a 150% proportional band, automatic reset and rate action. The 3 to 15 psi pneumatic output signal of the flow controller is sent to the flow control valve installation. A full opening 30-in. valve, equipped with power pack and operator, is used downstream of the meter runs to maintain constantly the desired flow through the station.

Two of the seven meter runs now in service, numbers 6 and 7, are equipped with electric-motor-driven valve operators to open or close these runs automatically to maintain a differential pressure on the other five manual runs within the differential pressure limits of 20 to 80 in. of water. This

Permanent pig traps and launchers are installed on the main line and gathering lines to provide for onstream pigging.

differential pressure is sensed on the manual runs, either number 1 or 2.

In operation, one or both of these runs will remain open at all times. If the flow declines, one or both of runs 6 and 7 will close automatically to maintain the differential pressure control limits. If the flow continues to decline, and the minimum differential pressure limit is reached, the control panel at Needles and Roswell will flash a light. When this happens the station personnel will close sufficient manual runs to raise the differential pressure on all runs in service, including runs 1 and 2, to satisfy the differential pressure control limits.

Automatic switching equipment is incorporated within the master control panel along with the encoder and telemetering equipment. The master control panel contains the flow controller and computer, the recording and indicating devices.

Static and differential pressures, and the pressure downstream of the flow control valve, the computed flow, and gas temperature, are all recorded at Needles. Indicating lights mounted on the Needles control panel show the status of the station control: Remote or local, automatic or manual, communication circuit on battery standby, set point deviation, orifice differential pressure high, and orifice differential pressure low.

The control board at Roswell displays for the dispatcher the necessary flow information that is telemetered from the Needles measuring station. The telemetering equipment encodes that flow data at Needles and it is transmitted to Roswell over the wireline d-c control circuits. This circuit is designed on a time share basis such that the data are sent and received on the same line.

Upset or abnormal conditions at Needles can initiate data transmission at any time from the station to the dispatcher. Thus the dispatcher is constantly informed on conditions at the metering station.

The following information is received at Roswell from Needles and displayed by indicating lights:

Station on remote control
Station on local control
Station on automatic control
Station on manual control
Communication circuit on battery standby
Flow set point deviation
Differential pressure high
Differential pressure low.

In addition to the data indicated by lights, the following information is displayed in digital form:

Rate of flow through station
Number of meter runs in service
Station inlet pressure
Orifice meter differential pressure
Station pressure after flow control valve.

The above information provides the dispatcher with the data necessary for him to completely control the metering station. To carry out this control, he has the ability to select where the station is to be controlled from, whether remote or local, and how the station is to be controlled, whether automatic or manual. For the normally remote automatic control situation, the dispatcher at Roswell merely pushes the button to place in service the automatic flow control panel at Needles, and then selects the type of control to be exercised . . . automatic or manual control of the meter runs in service. When the dispatcher pushes these buttons, the data are automatically encoded and telemetered over the control lines to Needles, where the orders are received and executed. The data are automatically flashed back to the dispatcher, allowing him to observe the progress of the automatic execution of his orders. And he has the ability to demand data recall at any time should a mistake be made in transmission.

Many Factors in Gigantic Project

Many facts other than those already discussed help to point up the gigantic proportions of this project.

For example, Gulf Interstate Company, who designed, engineered, purchased, and supervised the entire project, had an approximate 460 employees on the job during peak construction. There were some 300 field employees and about 160 office workers. These included division engineers, inspectors, material men, design engineers, and material take-off men.

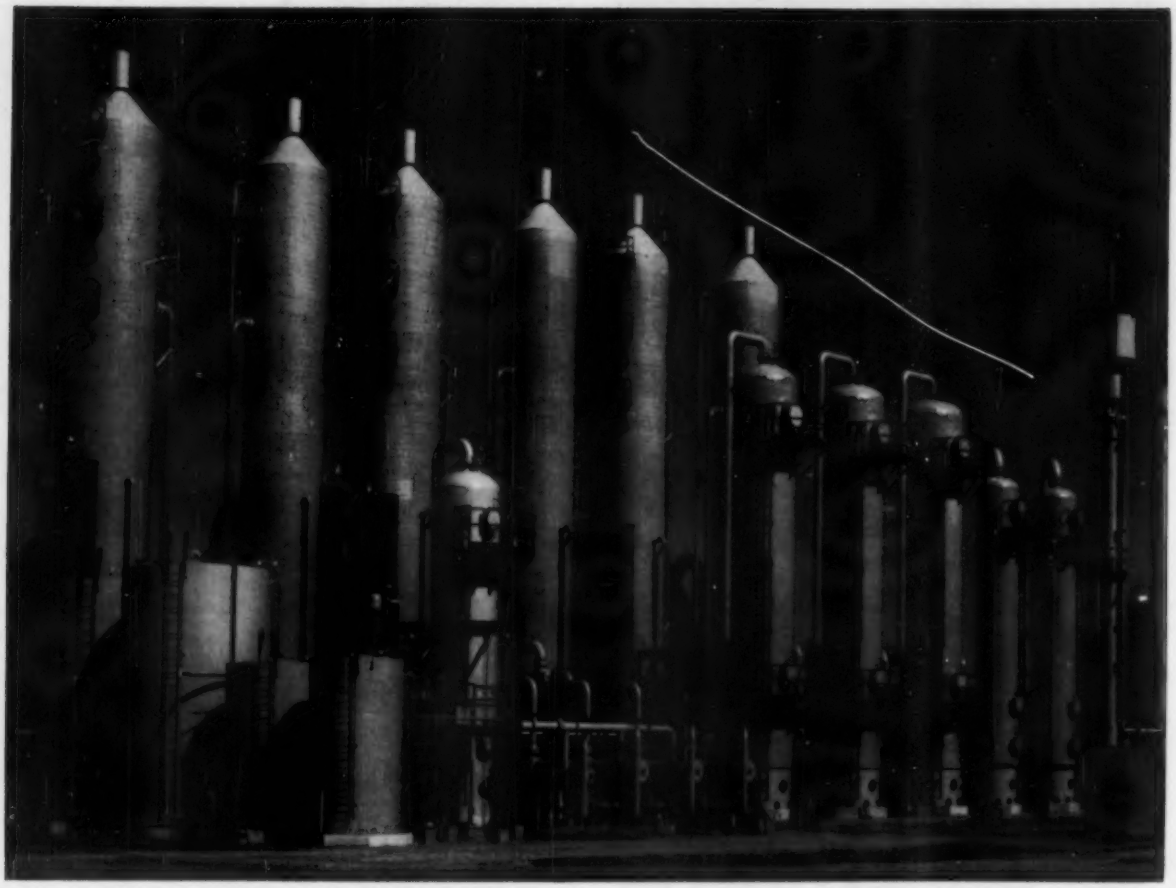
The contract for constructing the pipeline was let to three prime contractors, on two contracts. For the 30-in. main line, 20 and 24-in. laterals, Houston Contracting Company and H. C. Price Company had the contract jointly. Sheehan Pipe Line Construction Company had the gathering system. R. H. Fulton and Company was a sub-contractor on the main line, 24-in. lateral, and gathering system. Western Pipe Line, Inc., was subcontractor on the laterals and gathering system.

Eleven spreads were used, with a peak manpower of 3100. Approximately 1,250,000 lb of welding rod was used. About 2,500,000 lb of 40% gelatin explosives and some 2,250,000 lb of 60% gelatin explosives were required to remove the 15% rock per lineal foot that was found in rocky areas.

Contractors had a total of approximately $19,000,000 worth of equipment on the job, and used about $1,250,000 worth of gasoline, diesel fuel, lubricating oil, and grease.

First construction began late in November 1959, and gas was available for delivery at Needles on July 26, 1960. This is the time it took to lay 645 miles of 30-in. pipe, 452 miles of 24-in., 61 miles of 20-in., 32 miles of 16-in., 112 miles of 12-in., 185 miles of 10-in., 152 miles of 8-in., 194 miles of 6-in., and 186 miles of 4-in.; to apply approximately 32,000 tons of enamel, 114,000 gal of primer; connect some 200 gas wells, all with meter runs in sizes from 2-in. single to 10-in. multiple; install packaged glycol dehydration units at approximately 90% of the wells; and test the line partly with water and partly with gas. Additionally, there were seven plants connected with various types of dehydration equipment and meter runs of various sizes.

At Monument, New Mexico, a 25,000,000 cu ft per day molecular sieve type dehydration plant was designed and installed by Gulf Interstate Company. In the Puckett field a carbon dioxide removal and desulfurization plant was de-



Plant installed at Fort Stockton, Texas, for treating sour gas is first of its type built in the United States and never before has been used on a high pressure natural gas pipeline system anywhere.

signed and built by Brown and Root, about which more will be said later. At Keystone station a glycol dehydration-amine desulfurization unit was designed and built by Hudson Engineering Corporation to handle 65,000,000 cu ft of sour gas per day.

Most of the well measuring stations are skid-mounted, with a house built on the skid to protect the men reading and calibrating meters. These units are portable and completely salvageable upon abandonment of a well. They can be moved in their entirety from well to well, and are designed so that a large or small run may be put in with a minimum amount of labor and cost.

There are two check measuring stations in the system . . . of two different types. The check measuring station at Roswell is a vortex-velocity mass meter. These meters are not affected by compressor pulsation and consequently can be used inside the station yard. They are 10 in. in size and so designed that two meters on each lateral system will handle a maximum flow of 320,000,000 cu ft a day. The second check measuring station is at Pampa, Texas, at Station P-3. Here there are two 10-in. orifice plate runs on the 24-in. line coming from Canadian, with four stub ups for future runs. On the line from Cactus station in the Hugoton field there are two 6-in. orifice runs with one future stub up, and on the south side from Lefors and Shamrock there are three 6-in. orifice runs with space for one more in the future.

The main line has an elevation variation from a low at the Colorado River of 470 ft to a high of 8125 ft in Schultz Pass, north of Flagstaff, Arizona. The West Texas lateral has an elevation variation of from 2450 to 3750 ft, and the Panhandle lateral a variation from 2300 to 4550 ft.

All welds on the class 2 and 3 locations were 100% X-rayed, and on the class 1 locations approximately 60% X-rayed. Those contracting the X-ray work had a maximum of 35 men and about 18 units on the job during peak period of construction, and used approximately 740,000 ft of film and 2700 gal of chemical.

In addition to the men and equipment representing the contractors, Gulf Interstate rented portable units and personally X-rayed all tie-in welds.

Permanent pig traps and launchers were installed on the main and gathering lines to provide for on-stream pigging, and for this reason valves are of the full-opening type. On the main line 30-in. ball type full-opening valves are used along with automatic line break control operators. On the 24-in. lateral, non-lubricated valves are used with automatic line control operators. On the smaller line, full line size block valves were installed to permit passage of pigs. In this manner, all lines longer than one mile can be pigged while still flowing gas.

To make the preliminary survey, the line was separated into five divisions and 14 five-men parties ran a typical pipeline cross-country survey. In so doing good use was made of four-wheel drive vehicles to traverse the rough terrain, sand, and snow encountered during the survey period, and in some instances there was difficulty in finding section corners in the unsurveyed lands.

The final, or as-built, survey was run immediately behind

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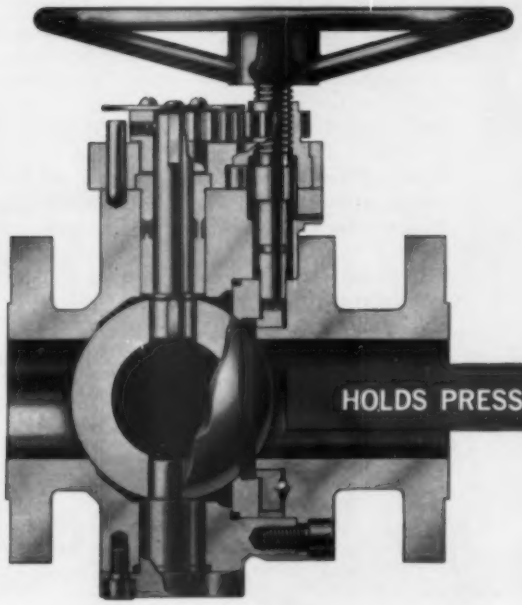

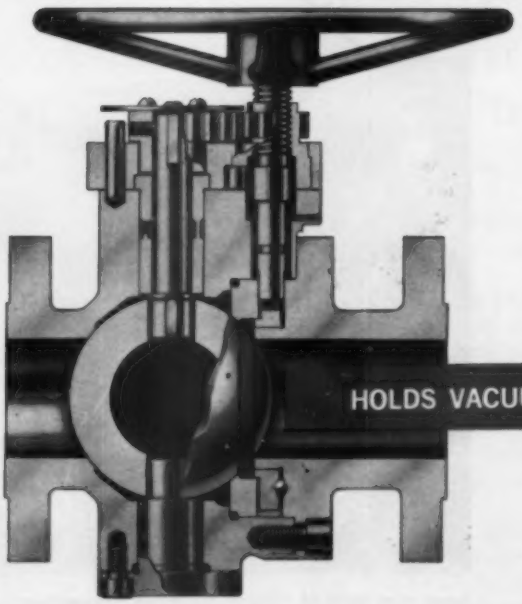

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the contractors as the line was being constructed. In this way it was possible to obtain accurate P's, pipe lengths and the actual footage of each pipe manufacturer for the strip maps.

Right-of-way was acquired from numerous federal, state, and quasi-public agencies, as well as the usual number of fee owners. Reservations and restricted lands of the Mohave, Navajo, and Laguna Indians are traversed in addition to the vast expanse of public domain.

An interesting by-product of the acquisition of rights-of-way in New Mexico and Arizona has been an enrichment of the history of the early West. The Federal Antiquities Act of June 8, 1906, which has been emulated by the legislatures of New Mexico and Arizona, provides for the protection of prehistoric ruins and objects situated on the public lands. To comply with these regulations, three eminent archaeologists-managed parties scouted the right-of-way ahead of construction searching for sites of interest. They supervised the excavation of numerous Indian pueblos, kivas, burial grounds, and objects of historic value, that otherwise would have been damaged or destroyed. Sacred grounds were identified and saved from desecration where possible. These findings are now being carefully photographed, cataloged, and stored at a National Park Service warehouse in Globe, Arizona. A report is being prepared for publication that will preserve these significant artifacts for posterity.

Puckett Field Treating Plant

The Puckett field treating plant, designed and built by Brown & Root, Inc., is the first of its kind in America. Its function is to remove hydrocarbons, hydrogen sulfide, carbon dioxide, and water from a sour natural gas and deliver a gas that will meet specifications required for pipeline transportation and sales.

The carbon dioxide and hydrogen sulfide are removed from the raw gas by Giammarco-Vetrocoke processes based on patents held by Vetrocoke, S.P.a. of Marghera, Italy. Brown & Root, Inc., is licensed to utilize these processes.

The plant could essentially be called a CO_2 removal plant, as the sour gas consists of 28% carbon dioxide and 0.02% hydrogen sulfide. The treatment reduces CO_2 content to less than 2% and completely removes the H_2S. Plant capacity is 180,000,000 std cu ft per day of sour gas with a plant inlet pressure of 1050 psig and an outlet pressure of approximately 1000 psig.

One of the major features of the plant is freedom from corrosion in the treating solution circulation and regeneration system. Accordingly, all process equipment is fabricated from carbon steel and the severe corrosion problems normally associated with acid gas removal plants are completely avoided. The treating system uses a potassium carbonate solution that is activated by metallic salts.

Three parallel carbon dioxide contactors and two parallel hydrogen sulfide absorbers have been provided. Each of the H_2S contactors is designed for 70% of plant design. Two of the CO_2 contactors will handle 80 - 90% of plant design. All contactors are packed with ceramic raschig rings.

Four sets of solution circulation pumps are provided, each driven by a hydraulic power recovery turbine and a steam turbine connected in tandem. Three of these solution pump arrangements will handle design solution flow.

Plant utilities consist of a water treating unit, complete electric power generation facilities, steam generation plant, and a cooling tower. Steam and cooling water requirements are said to be considerably lower than the acid gas processes previously used for similar service. The cooling tower is rated at 2200 gal per min and steam requirements are approximately 50,000 lb per hr. Boilers generate a 600-psi superheated steam for driving steam turbines at the solution pumps. Exhaust steam is utilized for solution heating with 100% condensate return to the boilers.

Other facilities provided are warehouse, complete maintenance shops, laboratory, fire water system, and air-conditioned offices and change room.

The plant has been operated successfully on one of the three parallel treating streams.

Contractors

Many contracting firms had a part in the Transwestern project. Gulf Interstate Company designed, engineered, purchased, and supervised construction of the entire project.

Line construction: H. C. Price Company, Houston Contracting Company, Western Pipe Line, Inc., R. H. Fulton and Company, Sheehan Pipe Line Construction Company.

Stations: Mid-Valley, Inc., prime contract. Hudson Engineering Corporation, Keystone purification unit and booster station. Delta Engineering Company, Dalhart booster station. Hudgens Construction Company, Needles measuring station.

Pipe stringing: Dunn Bros., Parkhill Truck Company, J. O. "Red" Willett.

Overhead bridge design: Wilder Kenan and Watts.

Overhead bridge construction: Harry Newton, Inc.

Station housing: Southern Mills and Manufacturing Company, M. L. T. Construction Corporation.

VHF communications system: Motorola Communications and Electronics.

Carbon dioxide plant: Brown and Root.

Yard coating: Texas Pipe Coating Company, Wes-Tex Pipe Coating, Inc.

X-ray welding: Industrial X-Ray, Western Industrial X-Ray, and Richardson X-Ray.

Continue to Page D-38 for "The men who run Transwestern Pipeline"

Seven miles north of Needles, California, Transwestern delivers the gas to Pacific Lighting Gas Supply Company. Dual 24-in. lines were installed under the Colorado River by the latter. Here concrete-encased pipe is being winched across the river.

2-pen Foxboro Dynalog Recorders chart both upstream interface profile and station profile on Phillips' two pipelines. Upstream record allows operator to select best cut point well in advance of interface's arrival.

Automatic Foxboro interface detection system eliminates guesswork at Phillips pipeline terminal

operators get interface profiles in advance...know exactly when to switch tanks

There's nothing haphazard about interface detection at the Phillips Pipe Line Company Terminal in East Chicago, Indiana. A Foxboro Interface Detection System sees to that.

This unique Foxboro system is based on the fact that even slight differences in grades or brands of petroleum products have measurably different dielectric constants. Sensitive Capacity Dynalog* Recorders measure this difference, both at the pipeline delivery station, and at a point 3 miles upstream. Foxboro Teletax* Telemetering brings the two measurements together on a single chart at the delivery point.

From the shape of the upstream record, the operator selects the best cut point and sets his index. When station interface record matches index, switch-over is made.

Phillips dispatchers find their Foxboro system eliminates sampling and guesswork — cuts product contamination to a new minimum. It can do the same for you. Ask your Foxboro Field Engineer for full details, or write for Bulletin 20-11. The Foxboro Company, 389 Norfolk Street, Foxboro, Mass.

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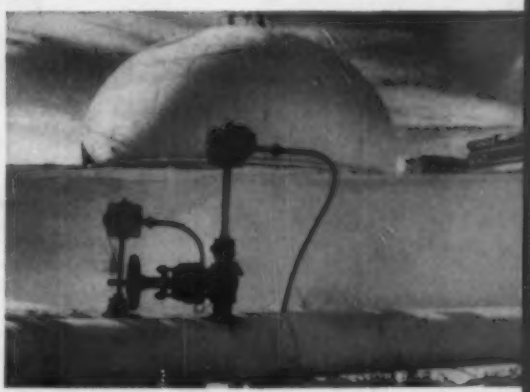

Capacity probes at upstream measuring point, and at terminal (shown above) measure dielectric constant of product passing through pipeline. Upstream measuring station is unattended — profile is telemetered to Dynalog Recorder at terminal.

THE MEN WHO RUN

WILLIAM K. WARREN
Chairman of the Board

William Kelly Warren of Tulsa, Oklahoma, is chairman of the board of Transwestern Pipeline Company. He shares with this new transmission company the wide experience of his more than 40 years in the oil and gas industry.

In 1922, he organized Warren Petroleum Company, predecessor to the present Warren Petroleum Corporation, which he serves as chairman of the board and chief executive officer.

Warren also is president and director of American Natural Gasoline Corporation, director and member of the executive committee of Gulf Oil Corporation, director of Warren Petroleum International Corporation, director of American Life Insurance Stock Fund, Inc., director of MKT Railway, and director of the First National Bank and Trust Company of Tulsa.

Warren is president of the International Petroleum Exposition, member and director of the American Petroleum Institute, member of the Mid-Continent Oil & Gas Association, member and past president of the Twenty-Five Year Club of the petroleum industry, and member of the advisory council of the College of Commerce of the University of Notre Dame.

Notre Dame has awarded an honorary doctor of laws degree to Warren, and the University of Tulsa has awarded to him an honorary doctor of science degree.

JOHN R. BUTLER
Chairman of the Executive Committee, Director, Secretary-Treasurer

John R. "Butch" Butler, in 1957, started developing the idea of a gas pipeline to Southern California and, in association with others, organized Transwestern Pipeline Company. Today, he is chairman of the executive committee, director, and secretary-treasurer.

Butler's long acquaintance with the industry began when he served as summer roustabout in his native Ohio's Lime-Findlay oil field, even before he received his BA degree from Miami University of Ohio. He joined Ohio Oil Company in refinery and sales in Robinson, Illinois, was transferred to the booming East Texas field where he again was roustabout for two years, and began serving as a petroleum engineer in 1934. Promotions were swift—to chief petroleum engineer; to district foreman and production superintendent in the company's Cotton Valley field in Louisiana; then to general manager of the Cotton Valley Operators' Committee, the first large cycling operation in the nation where the entire field was operated as a unit. In 1942, he became general manager of the Haynesville Operators' Committee, the first large water pressure maintenance project in the Mid-Continent area where the entire field was operated as a unit.

Butler returned to Texas in 1946 as executive vice president and general manager of J. S. Abercrombie Company and Old Ocean Oil Company, positions which he resigned in 1948 to become an independent operator and petroleum consultant as J. R. Butler and Company, now Butler, Miller and Lents, in which Butler is senior partner. He also is president of the Reef Corporation and J. R. Butler and Company, and director and former president of Butler-Johnson, Inc., oil well drilling and contracting firm.

JOHN R. McMILLAN
Member of the Executive Committee, Vice Chairman of the Board

John R. McMillan's association with Transwestern Pipeline began at its date of incorporation in 1957. He served as president and director from that time until June 1958, when he became director. Since May 20, 1959, he has been a member of the executive committee and vice chairman of the board of directors of the new transmission company.

McMillan attended UCLA and received his BS degree in mechanical engineering from the California Institute of Technology, after which he became a full-time employee of Barnsdall Oil Company where he had worked as a draftsman during his college years. He served Barnsdall for 14 years—first, in various capacities in the California oil fields, and later in the company's land and geological department.

In 1943, he joined Fullerton Oil Company as petroleum engineer and assistant manager of field operations, later becoming a director and vice president in charge of production and exploration. He was president and director of Full-

TRANSWESTERN PIPELINE

erton Oil and Gas Corporation in 1954 during its merger with and into Monterey Oil Company and then became executive vice president and director of Monterey.

He is a director of Huntington State Company; has served as chairman of the Petroleum Branch of AIME and the Wildcat Committee of WOGA; and is a member of the American Association of Petroleum Geologists.

MILLS COX
President

Mills Cox, president of Transwestern Pipeline Company, has been directly engaged in drilling, producing, and transportation for approximately 35 years and has the distinction of having attended the first statewide oil and gas proration meeting held by the Texas Railroad Commission and all Texas proration hearings during a ten-year period thereafter.

While working toward a Bachelor of Law degree from Baylor University, he performed summer work in the Desdemona and Ranger, Texas, oil fields. He attended Yale University Graduate School of Business Economics.

From 1921 until January 1942, he was associated with the Mills Bennett interests in Houston, Texas—serving as vice president of Mills Bennett Production Company, president of Liberty Pipeline Company, and vice president of Carter Drilling Company.

Following a tenure of duty with the U. S. Army Air Corps during World War II, Cox joined H. L. Hunt in Shreveport, Louisiana, and then Texas Eastern Transmission Corporation as manager of gas reserves and gas supply. In 1950, he was elected vice president of Texas Eastern Transmission Corporation and vice president and director of Texas Eastern Production Corporation to direct the activities of that organization. In 1952, he was elected a director and vice president of Wilcox Trend Gathering System, Inc.

Cox has made many appearances before the Federal Power Commission and has closely followed conservation practices in the various oil-producing states.

Ned C. Turner, Transwestern Pipeline Company's vice president in charge of engineering and operations, is a pioneer in the development of gas chromatography and the author of several technical papers on the subject of gas analysis by adsorption methods.

Turner received his chemical engineering degree from Ohio State University. He served as gas chemist for the

NED C. TURNER
Vice President, Engineering and Operations

Baltimore Gas Engineering Corporation in Charleston, West Virginia, and then, in the early 1930's, spent two years in Russia working for the Soviet government on plans for natural gas and light hydrocarbon facilities.

During World War II, he was chief engineer for the engineering and construction division of Jones and Laughlin Steel Corporation, where he supervised the engineering of plants for the manufacture of 100 octane aviation gasoline for the Defense Plant Corporation.

Prior to joining Transwestern, Turner was vice president of Hudson Engineering Corporation, where he supervised the engineering of numerous projects in the natural gas and petrochemical industries in the United States, South America, and the Middle East. In Pakistan, he directed the engineering of a large natural gas purification plant and the metering and regulation facilities serving Sui Gas Transmission Company's gas pipelines from the Sui field to Karachi and Multan.

WILLIAM B. PADON
Director and Vice President, Administration

William B. Padon, who holds a degree in finance from the University of Notre Dame and has attended Harvard University for an advanced management course, is a director and vice president in charge of administration of Transwestern Pipeline Company.

Padon performed summer work for Warren Petroleum Corporation from 1939 to 1942. After graduating from Notre Dame and serving 44 months in the U. S. Army, he rejoined Warren in April 1946, and was assigned to the natural gasoline sales division in Tulsa, Oklahoma. He transferred to the division's Houston, Texas, sales office for a

time and then was reassigned to Tulsa and placed in charge of special products sales.

Warren Petroleum named Padon vice president in charge of projects and planning in 1956. He was elected to the board of directors in 1959.

Padon is a member of the American Petroleum Institute, Natural Gasoline Association of America, and the Pipe Liners Club of Tulsa.

ROBERT M. CHAN
Director and Consultant, Gas Contracts Procurement

Robert M. Chan retired as first vice president of Magnolia Petroleum Company in 1957 and became a director of Transwestern Pipeline Company—which he also serves as consultant, principally in the procurement of gas contracts.

Chan attended New York University, became a certified public accountant in New York, and engaged in accounting and auditing. At the time of the merger of Standard Oil Company of New York and the Vacuum Oil Company, he was vice president of Vacuum Investing Company. He became a member of Socony-Vacuum's central marketing department and occupied that position until his transfer to Magnolia in 1935 as comptroller.

He was elected director and assistant vice president of Magnolia in 1942, vice president in 1945, and first vice president in 1952.

Chan is a director of the Texas Mid-Continent Oil and Gas Association and a member of the American Petroleum Institute, Independent Petroleum Association of America and its efficient practices committee, and the Dallas Area Arbitration Panel of the New York Stock Exchange.

PAUL F. McBRIDE
Operations Manager

Transwestern Pipeline Company's operations manager is Paul F. McBride, who was responsible for the design and construction of Pacific Northwest Pipeline Corporation's gas facilities.

McBride's career began when he received a BS degree in mechanical engineering from Texas A&M College. He joined United Gas Pipe Line Company's engineering department and worked on design and construction of various natural gas processing, compressor, and pipeline facilities. Later, he was employed as assistant chief engineer by Algonquin Gas Transmission Company.

He joined Fish Northwest Constructors, Inc., as assistant chief engineer when work started on the Pacific Northwest Pipeline system, and later transferred to Fish Northwest's construction headquarters in Salt Lake City, Utah, as assistant superintendent of construction, becoming chief engineer of Pacific Northwest at the conclusion of the initial phase of construction. In 1958, he was promoted to general superintendent of operations and was responsible for the operation and engineering of Pacific Northwest's system until joining Transwestern.

WILLIAM A. KOROS
Controller, Assistant Treasurer, Secretary

William A. Koros, former assistant to the vice president, rate department, of the Charleston Group Companies of the Columbia Gas System, is Transwestern Pipeline Company's controller and assistant treasurer and secretary.

Koros has a BS degree in business administration from the University of Nebraska, is a certified public accountant in the states of Texas and Nebraska, and is a former Federal Power Commission field examiner in the Bureau of Rates.

Koros also has served Trunkline Gas Company as chief accountant and Gulf Interstate Gas Company as assistant treasurer and chief accountant, a position which he retained after Gulf Interstate was succeeded by Columbia Gulf Transmission Company in December 1958. He transferred to his position with the Charleston Group Companies in June 1959.

BEN A. COPASS, JR.
Manager Gas Purchase Contracts

Ben A. Copass, Jr., manager of gas purchase contracts for Transwestern Pipeline Company, holds a BBA degree from the University of Texas and an LLB degree from South Texas College of Law. He was admitted to the Texas Bar in December 1959, after having scored highest of 181 persons who took the state bar examination in October of that year.

Copass joined Humble Oil and Refining Company in 1947 and served that company in various capacities — in field operations, in the gas department as gas contractman handling gas purchases and sales, representing the gas department in Federal Power Commission matters, as gas contractman in charge of gas matters for the eastern division, and in the marketing department as sales representative handling purchases and sales of liquid gas plant products.

JAMES H. BEELER
Chief Dispatcher
Last employer: *Texas Eastern Transmission Corporation as assistant chief dispatcher*

BRUCE J. CALDWELL
Superintendent of gas measurement
Last employer: *Columbia Gulf Transmission Company as superintendent of gas measurement*

RAYMOND L. COOK
Chief pilot
Last employer: *Warren Petroleum Company as chief pilot*

JACK EUBANKS
District superintendent
Last employer: *Houston Texas Gas & Oil Corporation as compressor station superintendent*

FERN H. GOODWIN
District superintendent
Last employer: *Westcoast Transmission Company as division superintendent*

CARL R. SISSON
Division manager
Last employer: *Texas Eastern Transmission Corporation as manager of operations of the Little Big Inch Division*

WILLIAM J. REESE
District superintendent
Last employer: *Columbia Gulf Transmission Company as section superintendent*

P. T. REED, JR.
Plant superintendent
Last employer: *Columbia Corporation as gasoline plant superintendent*

MAX KRUTSINGER
Rights-of-way superintendent
Last employer: *Gulf Interstate Company as superintendent of rights-of-way and ad valorem taxes*

LESLIE M. FISHER
Division manager
Last employer: *Carthage Corporation as plant superintendent and assistant district superintendent*

Dial Telephone . . . get flowmeter reading

J. H. Rice, Marathon Pipeline Company president, inspects D-A-T-A unit that audibly reads back flowmeter readings over telephone or microwave systems.

AN ELECTRO-MECHANICAL "talking brain" is reducing from hours to seconds the time required by a pipeline company for checking readings on flowmeters at remotely-located pumping stations.

Developed by technicians of the Marathon Pipeline Company, a subsidiary of the Ohio Oil Company, Findlay, Ohio, the device does in 16 to 25 seconds a job with less error margin than a man was able to do by driving a round-trip of 14 miles every two hours for his flowmeter check.

Dispatchers in the company's general office at Findlay simply dial their telephones and ring the device (referred to as a Digital-to-Audio-Translator-Accumulator) which answers automatically. The pumping station identifies itself through a pre-recorded tape attached to a drum that begins to rotate at the telephone signal.

The successive series of revolutions of the drum actuates the proper playback heads, attached electronically to the various contacts of a digital counter, to read out the numbers from the respective tapes attached to the drum. This station identification and digital read out actually is a prerecorded human voice speaking the words and numbers clearly over telephone lines or microwave systems.

The company now has two installations at pumping stations as far away as 400 miles and plans to install more by the end of the year. Within a few years, Marathon expects to have more than 100 in use along its 5600-mile system.

J. H. Rice, president of Marathon, says the D-A-T-A device is the most reliable method they have found to relay pumping station flowmeter readings to the dispatching office. One unit in operation in a station near Alton, Illinois, reported the flow of 2,700,000 bbl of oil with only a 7-bbl error over a five-month period.

Chief maintenance of the D-A-T-A unit, Marathon says, is periodic replacement of tubes in the associated amplifier, which may function for years.

The D-A-T-A instrument, ordinarily operated by alternating current electric power, is also equipped with dry cell batteries and an accessary relay in case of power failure. The batteries would pulse the counter during a power loss.

L. J. Schwartzkopf, company pipeline communications technician, developed the idea for the device, with Continental Service, who will manufacture and distribute the instrument, making certain refinements.

D-A-T-A weighs about 26 lb and can be installed at a pumping station in about two hours. Both telephone and microwave communication systems can be utilized for transmitting. ★ ★ ★

Instrumentation, Controls, and Automation

Part 1: Telemetering

MAX T. NIGH

MEET THE AUTHOR

Max T. Nigh is a process control representative for IBM in the midwestern region, with headquarters in Chicago, Illinois. Previously he was actively engaged for 10 years in various phases of pipeline automation as an electrical engineer. He was concerned with designing centralized monitoring facilities, telemetering, pipeline instrumentation, electrical machinery and controls, and field installation with Service Pipe Line Company.

He was graduated from the University of Nebraska in 1945 with a BS degree in chemical engineering, and was first employed by California Research Corporation as a process development engineer in the petroleum chemicals division.

He is a member of AIChE, NSPE, and ISA, and is a registered professional engineer in the State of Oklahoma. He is past president of the Tulsa Chapter of Oklahoma Society of Professional Engineers and the Tulsa Chapter of the Instrument Society of America. Currently he is chairman of the Pipeline Committee, Transportation Division, ISA.

HUMAN RELATIONS has been, is, and will always be an important responsibility and a concern for all people in business. With automation becoming an increasing part of business activity it will be required for business people to appreciate "machine relations" in addition to human relations.

Machine relations covers a portion of the new technology that is expanding under the name of "automation." This technology is to meet the challenge of more work accomplished with less effort. The key to effective use of automation is to appreciate these machine relations, which will stand out in relief when the principles or concepts of automation are understood. It is not necessary to understand or make use of the mathematics involved in design or the choice of equipment to accomplish the purpose outlined above.

In this series of telemetering and control discussions, we are dealing exclusively with concepts. We will not discuss detail circuits, wiring diagrams, or detailed engineering design of equipment. Rather, we shall deal exclusively with different means of visualization of the principles involved in remote control, supervisory control, or supervisory indications and telemetering. All these terms have been used to describe the subject matter.

Both analog and digital forms of telemetering will be explained. Emphasis will be on those now widely used in industry. Many are particularly applicable to the pipeline industry — both gas and oil pipelines. These same principles extend into guided missile and rocket telemetering, but generally much higher speeds of transmission are used and often the information is transmitted for much shorter time durations. The measurement of time is usually expressed in millionths of a second whereas everything we are going to discuss, that is used in industry, is in tenths of seconds or in seconds.

As these techniques are so widely accepted in the industry and serve a useful and often vital function in business, it is most desirable for all personnel involved in the future operational methods of any business to appreciate the concepts of this type of automation.

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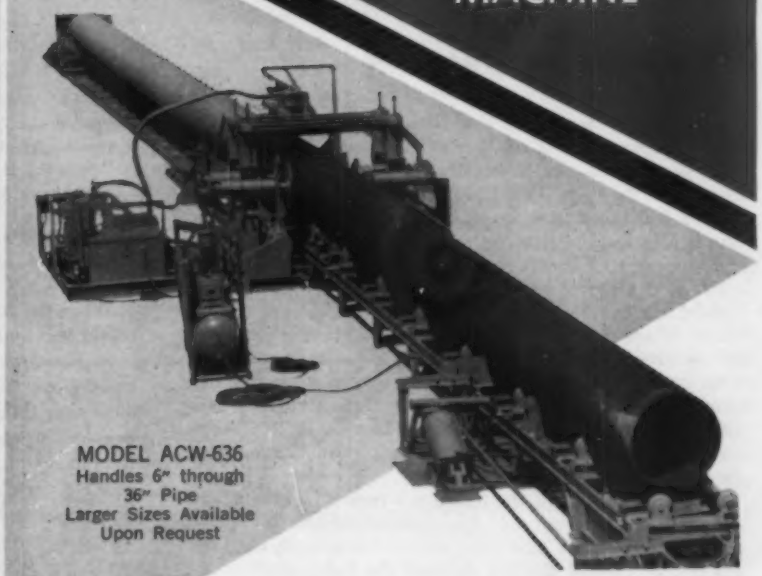

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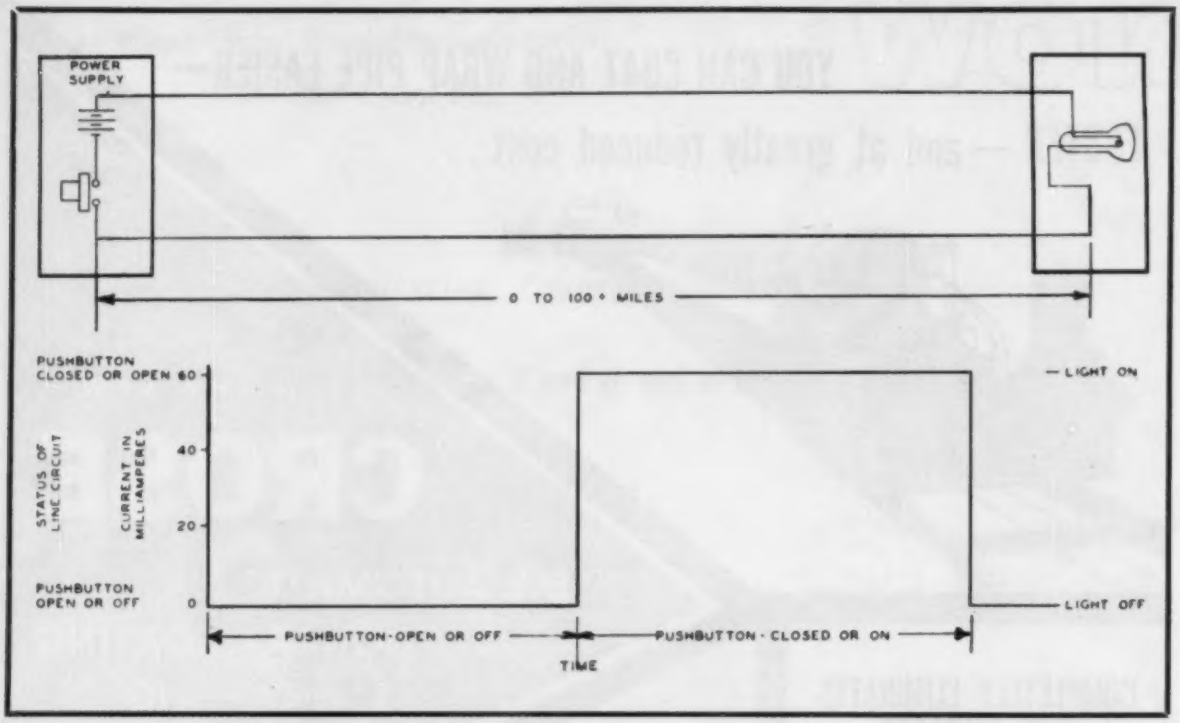


FIG. 1

Simple control loop

Fig. 1 shows a one-line schematic diagram with a pushbutton turning on and off the battery power supplied to a light. We have shown the battery and pushbutton some distance from the light. This distance could be anywhere from zero to 100 miles or more and still function satisfactorily. This is identical in principle to turning the lights on and off in a room in your home. The only thing we have done differently is to separate the light, and the battery power and pushbutton by a distance that exceeds a persons normal vision. When the distance between the pushbutton and light or "operated device" becomes great, in principle, we have what is considered to be a signaling system or in popular terminology a supervisory control or telemetering system. The concepts that we are going to discuss in this series involve no more complicated problems of visualization than the above fundamental example.

In the lower half of the figure is a means of graphically expressing the operation of this pushbutton and the operation of the light. We have time plotted horizontally, and the amount of current flowing through the light, pushbutton, and wires, is plotted vertically. We have shown approximately 62 milliamperes (ma) as the maximum current flowing when the pushbutton is closed and no current flowing when the pushbutton is open. This maximum current represents the limit usually specified for telegraph operation on wire line circuits. When the pushbutton is open, the current flowing is zero, and when we close the pushbutton, the current level is raised to 62 ma and is flowing at that level continuously, as long as we hold the pushbutton closed. When we open the pushbutton again, of course, the light goes off and the current drops to zero. Thus, we have shown a lower line for a duration of time with the light off and an upper line for a duration of time with the light on. This is a convenient manner to display a pulse pattern. Because the pulse occurred over a period of time we technically call it a pulse duration or time duration.

When the length of time the current is on is proportional to a pressure or a flow it is known as pulse or time duration telemetering.

When the "current being on" is used to indicate that a pump or motor is running it is known as a supervisory indication.

When the "current being on" is used to turn on a pump or motor it is known as a control. More about this later.

In Fig. 1 we were concerned with a direct current from a battery operating a light over a pair of wires. It is also possible over this same pair of wires to impress an alternating current, in addition to the direct current, and detect it at the other end with proper equipment. This alternating current can have any frequency between a few hundred cycles per second to 20,000 cps, which covers the audible frequency range, or can go on from 20,000 cps up to as high as 50,000 cycles per second.

By choosing the particular frequencies of alternating current we impress on the wire line carefully, we can build appropriate electrical sieves that will receive only these particular frequencies. Such receivers will accept only a particular narrow range of frequencies corresponding to a particular transmitter. This type of signaling removes our pushbutton and battery, at the transmitting end, from the telephone line and interposes a box between the wire line and pushbutton. At the receiving end, we have interposed another box between the telephone line and the indicating lamp. The function of the system is the same as in Fig. I, but the introduction of a tone transmitter and a tone receiver permits us to put many different signals over the same pair of wires.

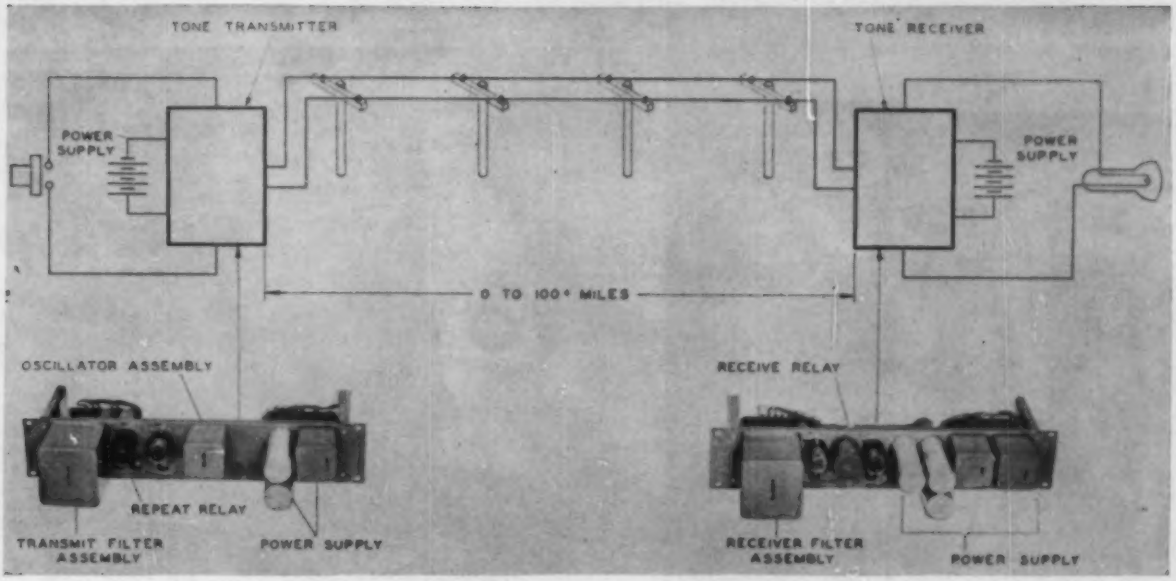


FIG. 2

Tone control loop

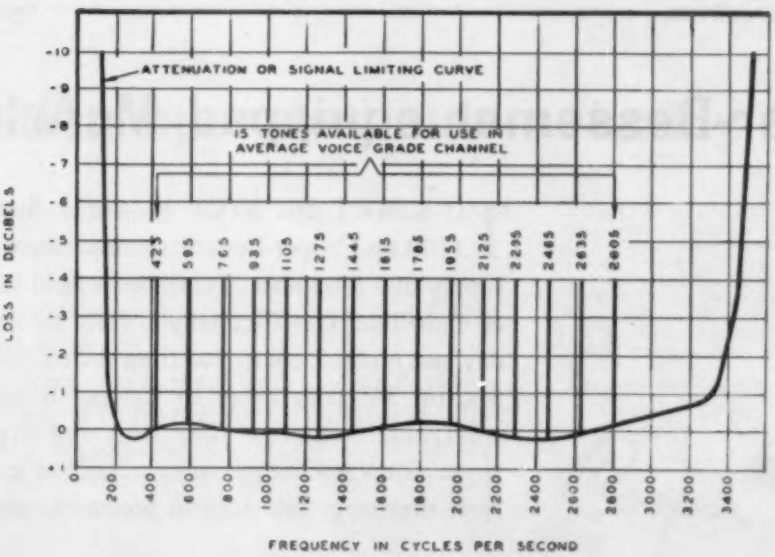
The physical equipment is shown in Fig. 2 with the transmitter components being made up of its own power supply, its oscillator creating an alternating current of a particular frequency and transmitting line filter. At the receiving end we find our electrical sieve in the form of a line filter, which will accept or pass, at a measurable level, only frequencies of a very narrow range. The receiving relay duplicates the action of the pushbutton at the transmitter. The power supply is to operate the receiving equipment composed of vacuum tubes filters and the relay, as well as the power to light the lamp, if desired.

Our home telephone provides a communication highway permitting alternating current signals ranging from a few hundred cycles per second to 3000 cps. This same communication highway or channel can be used for telemetering and control purposes by placing a number of discrete tones ranging in frequency from 200 to 3000 cps and impressing them on the voice channel.

Tone space on voice channel

Fig. 3 shows a typical attenuation or signal limiting curve for a leased voice channel and is typical of those provided by American Telephone and Telegraph Company. Adhering to conservative design practice, approximately 15 separate and discrete tone channels can be placed within this one voice channel. The vertical bars represent these discrete tone channels. These tones could either be amplitude modulated, or frequency shift, or frequency modulated.

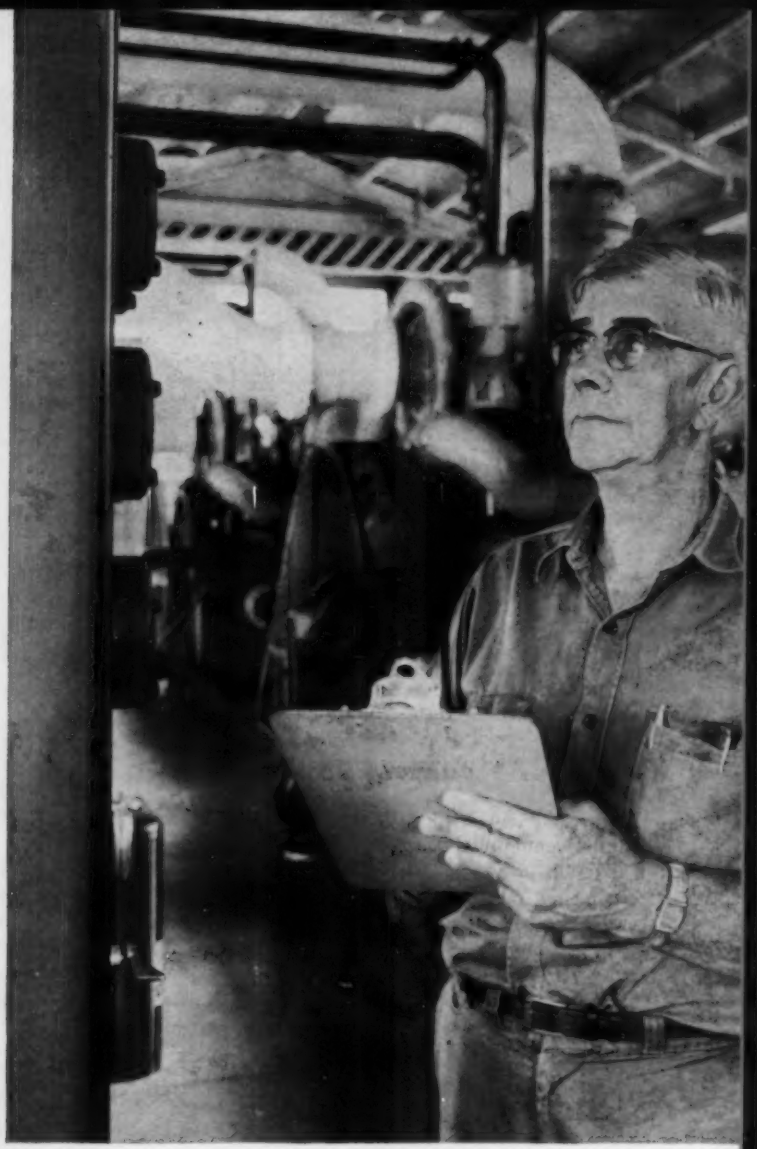
FIG. 3



Signaling in the case of amplitude modulation is accomplished by turning these tone transmitters on and off. In the case of frequency shift the tone frequency is shifted from one frequency to another, with both being very close to the carrier frequency (this is shown by the vertical bars).

Using newly developed frequency shift tone equipment, it is possible to increase the number of separate discrete tone channels, which can be placed within the voice channel, to approximately 30, or double the above mentioned conservative design level. This cannot be done, however, without sacrifices in reliability, line loading, and signal to noise ratio losses and is subject

At Crawford Station: En-Tronic Control actuates all functions at McArthur Station and records engine speeds and pressures. Shown here: W. E. Deeds, Engineer in Charge.



At McArthur Station: James Caldwell, Chief Engineer takes a reading from the En-Tronic Control of one of the Cooper-Bessemer compressors. This control actuates starting sequences and monitors the complete operation.

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At McArthur: This En-Tronic Control is a telemetering and supervisory control unit for the entire operation. Compressors can be started or stopped from this location as well as from Crawford.

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to the number of times the signals are repeated, etc. These considerations require careful study by engineers and are not always practical, so 15 is a sound representative figure that conforms to good telephone practice. In the case of 15 tones they are spaced 170 cps apart, with each tone having essentially no width to it, but rather corresponding to a particular frequency.

The frequency modulated tone channels are used with the variable frequency telemetering systems to be discussed in detail later. Essentially the tone channel frequency is modulated at a frequency of 15 to 35 cps, with the 15 to 35 cps being proportional to some measured electrical quantity. At the tone receiver the tone is demodulated to the 15 to 35 cps signal and this frequency then converted to a direct current signal. This will be discussed in more detail under variable frequency telemetering.

Tone space on speech plus physical channel

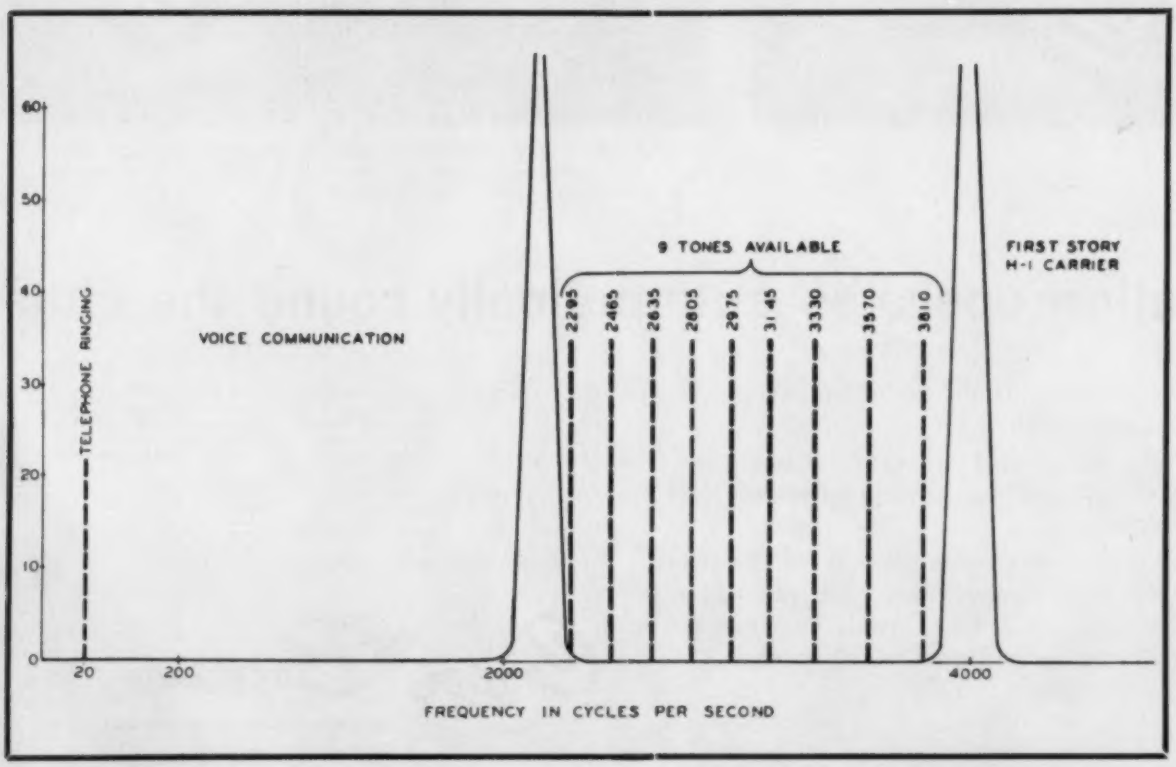
In Fig. 4 is shown the range of alternating current frequencies that can be placed on a pair of telephone wires and used for voice communication, control, and telemetering.

It is quite common for pipeline companies to have private wire line facilities for communication. When the wire line is used for voice communication only the voice spectrum of frequencies from 200 - 3000 cps are impressed on the wire line. Note the ringing frequency is only 20 cps. When telemetering is desired, the voice frequencies can be limited to a maximum of 2000 cps and still provide adequate intelligible and practical voice communication. It is possible by proper choice of filters, or electrical sieves, to use the frequency spectrum between 2000 and 4000 cps for telemetering. The spectrum above 4000 cps then can be used for voice carrier channels. Using 170 cps spacing of tones between 2000 cps and 4000 cps it is possible to place nine tones, or, as we have discussed earlier, nine separate push-buttons and lamps for signaling between locations for control in telemetering purposes. Again the spacing of tones is based upon conservative communication practice.

This particular frequency spectrum (2000 - 4000 cps) on private wire line communication systems, has been used very successfully for pipeline telemetering. It offers economical applications when the wire line is heavily loaded with carrier, say three channels.

A question might be asked, "Why not use higher frequencies where there is more room"? At the "speech-plus" level the range is only 2000 cps and is definitely limited, whereas above the third voice carrier channel (above 35,000 cps) there is unlimited frequency range. The difficulty with using these higher frequencies with conventional tone transmitters and receivers is the extremely high attenuation of the signal, or loss of signal strength. Distance is limited, and often does not exceed 50 miles. Also bad weather, particularly frost conditions on the wires, further attenuates the signal, and the practical distance is reduced even more. This results in unreliable operation.

FIG. 4



GAS CLEANERS:

A Qualitative Analysis

DR. NORMAN W. WIEDERHORN and ARNOLD W. DOYLE,
Arthur D. Little, Inc., Cambridge, Massachusetts

Many varieties of gas cleaners are used by the gas industry, with the oil bath scrubber the most prevalent type. Centrifugal or cyclone type cleaners also find considerable application, as do a large number of different types and designs of filters.

This report discusses operating principles of each of the above named types of cleaners on an individual basis. Much of the data included is based on results of research work performed on "Suspensoids in Natural Gas" for the A.G.A. as a PAR project and supervised by the Committee for Project NFX-12.

Filter-Type Gas Cleaners

A typical vessel containing a filter for gas cleaning is shown in Fig. 1. Gas flow through such a cleaner is indicated by the arrows, and as can be seen, all the gas must flow through the filter medium before the gas can leave the vessel. Cleaners of this type are very simple in design and operation, and with them it is possible to obtain very good cleaning with a relatively low pressure drop through the cleaner.

Filter-type cleaners, however, have certain associated disadvantages. In particular, their capacity is limited by the surface area of the filter medium. Furthermore, as the filter medium collects suspended particles, the pressure drop increases. Thus the initial low-pressure drop gradually builds up to the point where it will be greater than is observed with the other types of cleaners. As a matter of fact, if the cleaning element is not changed at suitable intervals, the pressure drop may build up to the point where the medium will rupture.

It is quite apparent that the heart of this type of cleaner is the filter medium that is used. A variety of filter media have been employed. These include resin impregnated paper media, special papers made from glass fibers and asbestos, fiber glass mats, and wool felts.

Efficiency of the various filter media for removing particles suspended in a gas stream varies considerably. Some filter media have efficiencies in excess of 99.9 percent for the removal of particles as small as 0.3 microns in diameter. Other commercial media have very poor efficiencies for removing such small particles. In addition, there is a considerable variation in pressure drop through the various media.

Unfortunately, there is very little correlation between pressure drop and cleaning efficiency of the filter media. Because of this, there is no simple procedure for predicting the filtration efficiency for small particles from pressure drop measurements. This is illustrated in Fig. 2.

In Fig. 2, we have plotted the percent penetration of the filter medium for 0.3μ particles as a function of gas velocity. The scale for percent penetration is logarithmic. Examination of this graph reveals that the percent penetration varies over a considerable range for the four filter papers, all of which are commercial media. In the lower portion of the graph, the pressure drop through the same media is given as a function of flow rate. The variation in the pressure drops are comparatively small as there is only about a two-fold range in the pressure drop. The variation observed in the efficiency of these media for removal of 0.3 micron par-

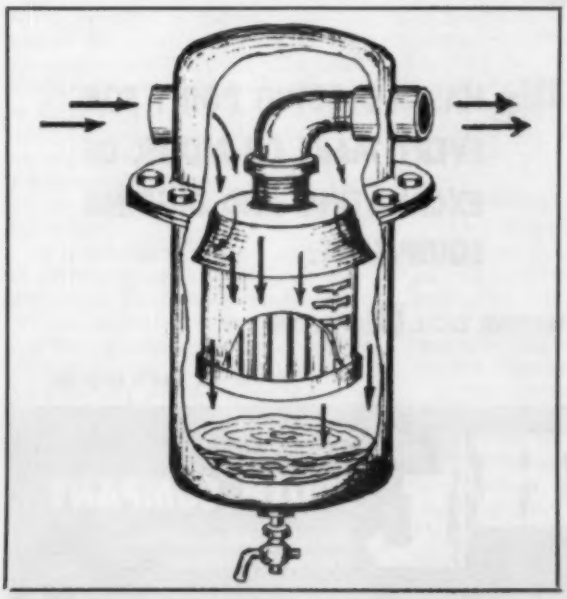


FIG. 1. Schematic of filter-type cleaner.

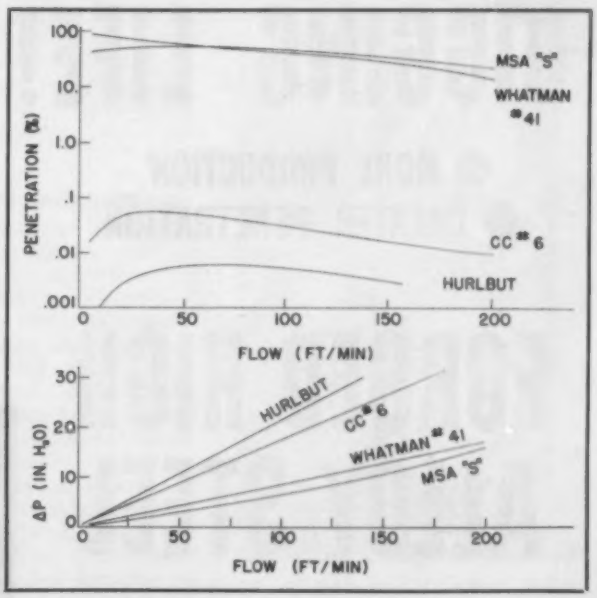
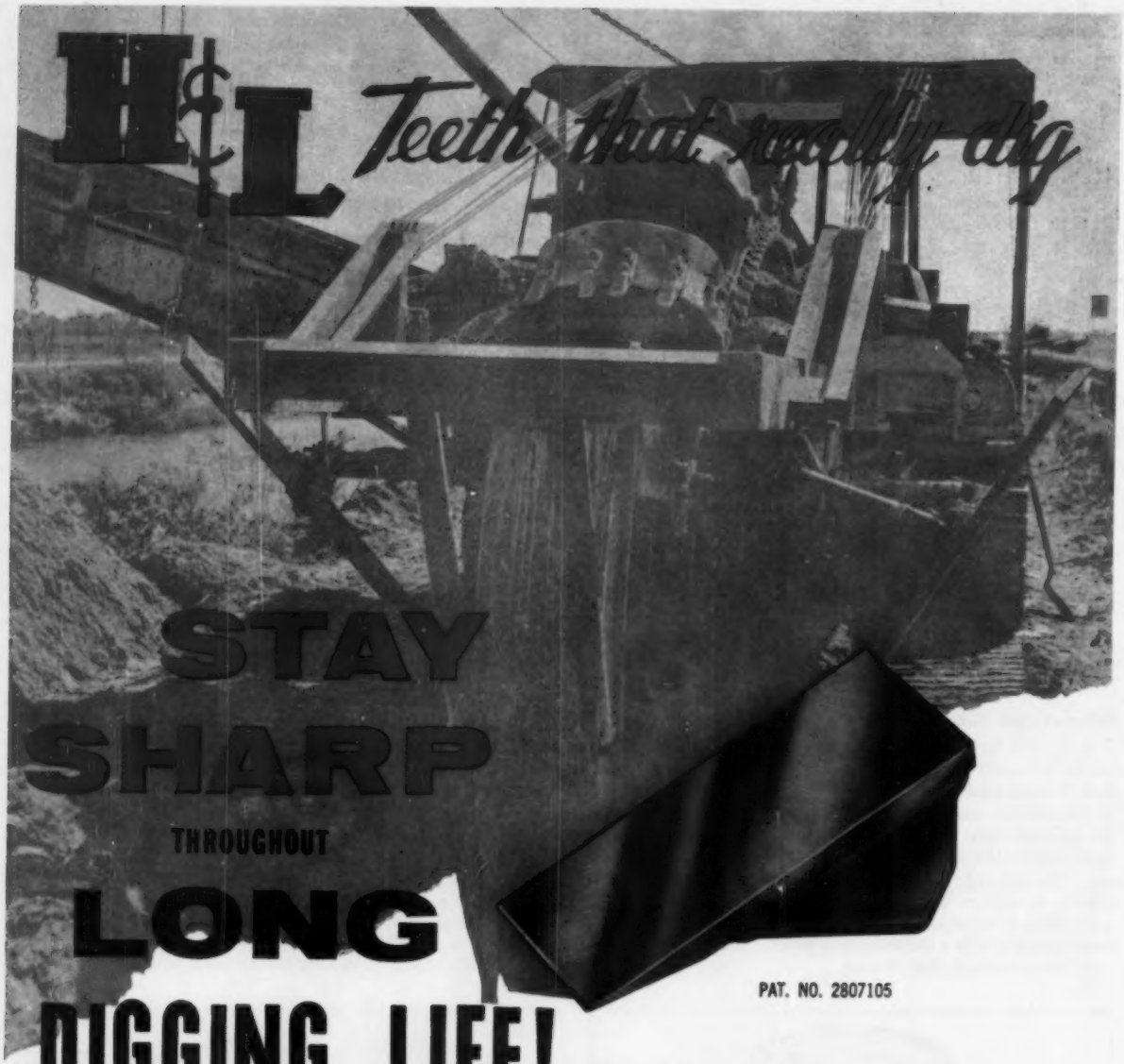


FIG. 2. Filter media performance.



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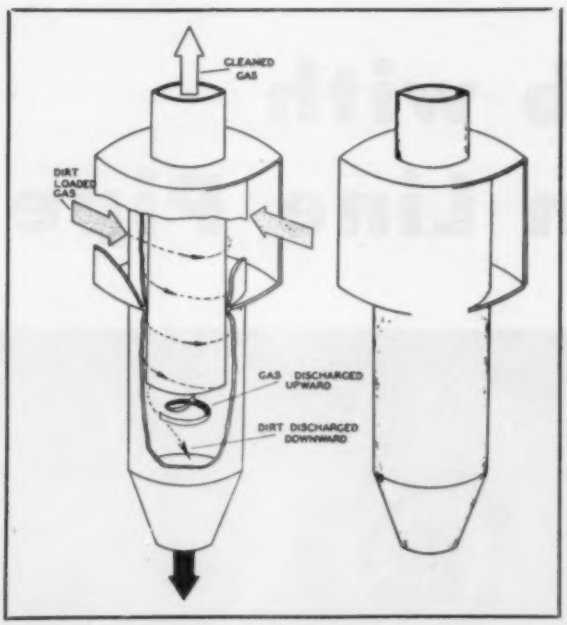


FIG. 3. Schematic of centrifugal separator.

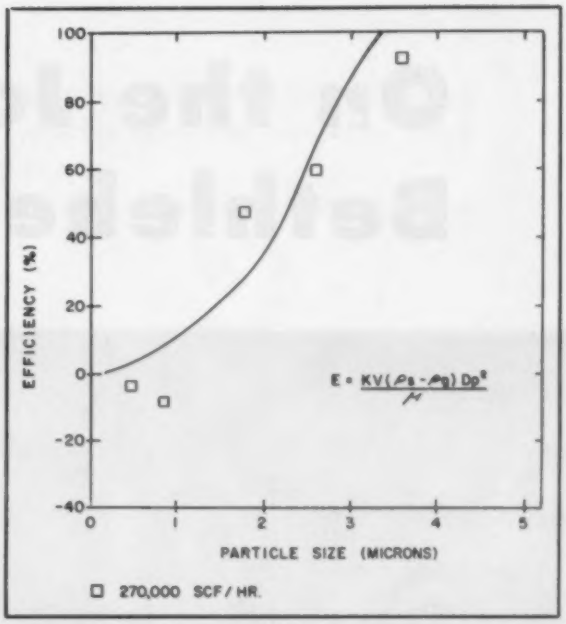


FIG. 4. Efficiency of centrifugal cleaner.

ticles, however, is very large. This is typical of what might be expected with various filter media and the design of a suitable filter medium is very often a difficult undertaking. It is really an art and not a science at this time.

Centrifugal Cleaners

Second on the list of types of cleaner is the **centrifugal cleaner** or **cyclone separator,** as it is often called. A schematic diagram of a typical centrifugal separator is shown in Fig. 3.

Gas flow through this cleaner is indicated by the arrows. The gas enters the cleaner and moves in a downward spiral. A vortex is formed at the bottom of the exit tube, and the gas then proceeds vertically up the tube and is discharged through the outlet. Particles in the gas stream are centrifuged out toward the walls of the tube where they are collected and swept downward by the downward motion of the gas. They are discharged at the bottom through the outlet.

In a commercial cleaner, a number of such tubes are mounted in a pressure vessel. The number of tubes in the vessel is determined by the line pressure and the gas velocity. A curve showing the performance of a typical centrifugal scrubber element is given in Fig. 4.

The solid line shown in this graph is a theoretical curve. Points drawn on the curve are experimental points that were observed in the field evaluation of a commercial cleaner. As can be seen, the agreement between theory and practice is reasonable.

Centrifugal separators are practical industrial cleaners. They are easy to operate and maintain and their capacity is limited solely by the size of the collection vessel which is placed below the centrifugal elements. Centrifugal separators also have certain disadvantages. Their efficiency for particles less than about 3 microns in diameter is poor in comparison to other types of available cleaning equipment.

There is also a tendency for agglomerates of small particles to be ground or dispersed in the centrifugal element. Small particles formed from the agglomerates may then be transmitted through the cleaner. This is indicated by the experimental points (lower left of graph) where we found that more submicron particles were transmitted through the cleaner than actually entered the cleaner. Effectively, this means we made small particles out of the large ones and then could not collect them.

Conventional Oil Bath Scrubbers

Third on the list are oil bath scrubbers. There are two principal types of oil bath scrubbers. The conventional or vertical oil bath scrubber is illustrated in Fig. 5. There are also oil bath scrubbers in use that contain a rotating member for collecting the particles.

In the **conventional oil bath scrubber,** the gas is introduced to the scrubber and must pass through the oil and then through contactor tubes. As it goes through the contactor tubes it sweeps up with it a cloud of oil droplets. The gas then passes through a mist extractor located at the top of the scrubber. The mist extractor functions to remove the cloud of oil and suspended particles from the gas. The gas then exits the cleaner. The mist extractor section is generally made either of corrugated veins or of a metal mesh. The oil that is removed from the mist ex-

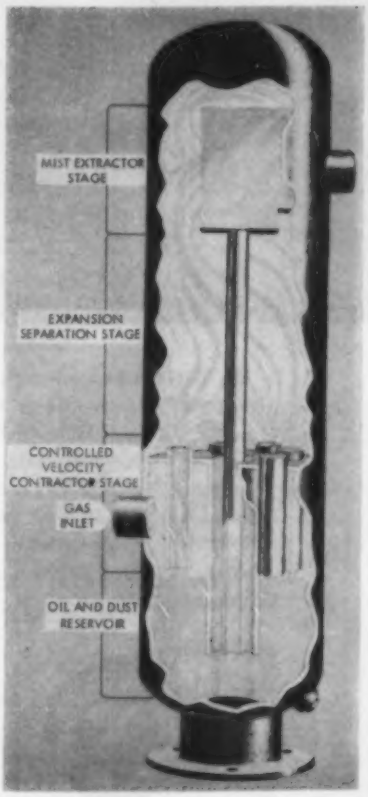
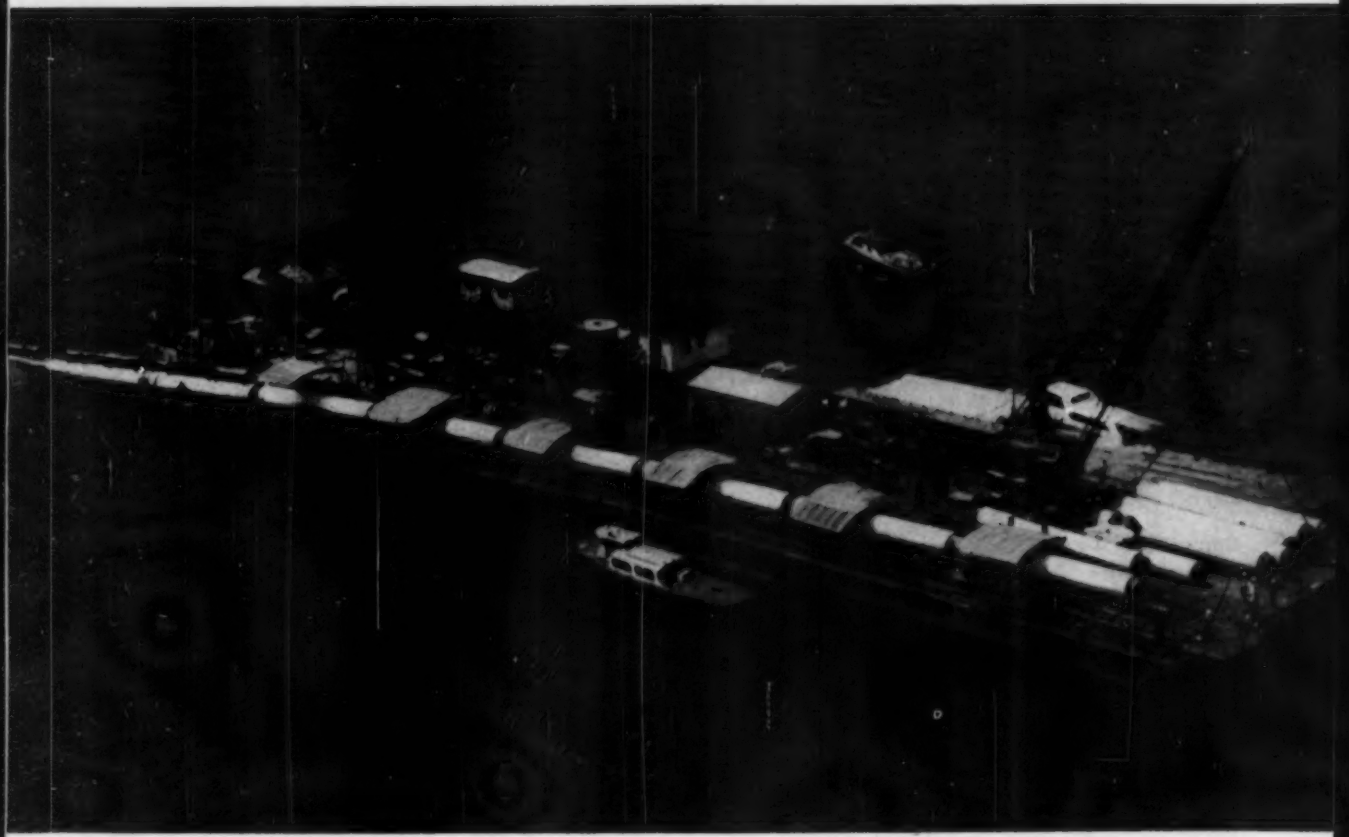


FIG. 5. Schematic of vertical oil bath scrubber.

On the Job with Bethlehem Line Pipe



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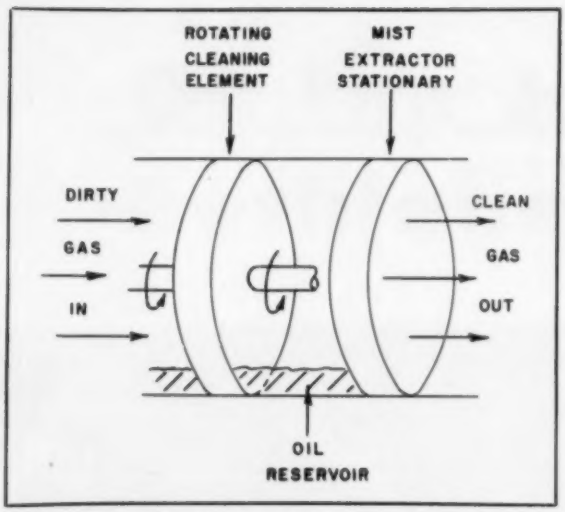

FIG. 6. Schematic of oil bath scrubber with rotating member.

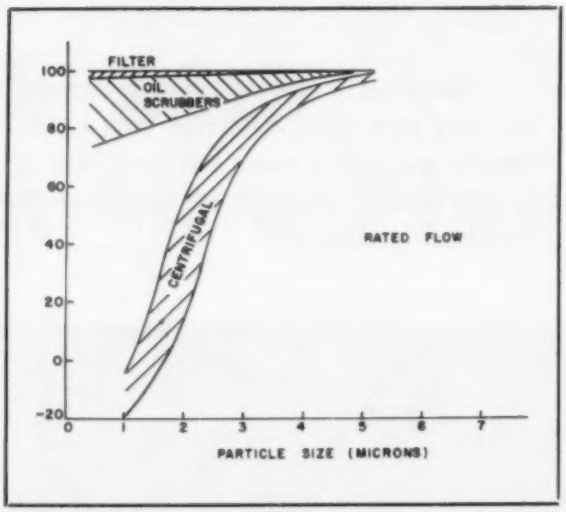

FIG. 7. Cleaning efficiency of gas cleaners.

tractor drains back down into the oil reservoir at the bottom of the cleaner. Number and size of the contactor tubes depends upon the capacity of the scrubber.

The mechanism whereby dirt is removed from the gas in such a cleaner has still not been settled. It has been claimed that the dust is removed primarily by impaction with the oil droplets. However, there must be other mechanisms operating as well. For example, we have determined the efficiency of an oil bath scrubber for removing particles when there was no oil in the scrubber. Even under these circumstances relatively high efficiencies were obtained for submicron particles. Thus, in addition to removal of dust by impaction on oil particles there apparently is some removal by settling and by impaction of the particles on various components within the vessel and within the mist extractor section. I do not mean to imply by this that an oil bath scrubber can be operated efficiently without any oil. If no oil were present, dust would collect at various points and then be blown through the scrubber. Whatever else the circulating oil may do, it does wash the dust down so that it collects in the oil reservoir at the bottom.

Rotating Member Oil Bath Scrubbers

The second type of oil bath scrubber is illustrated schematically in Fig. 6.

In this type of cleaner there is a rotating member that passes through the oil reservoir. Various designs have been used for rotating members — one manufacturer employs a group of concentric corrugated cylinders, while another manufacturer uses a wire mesh. This rotating member, in passing through the oil reservoir, is coated with oil. Cleaning takes place by impaction of the suspended particles on the oil-wet surfaces of the rotating member. Because this

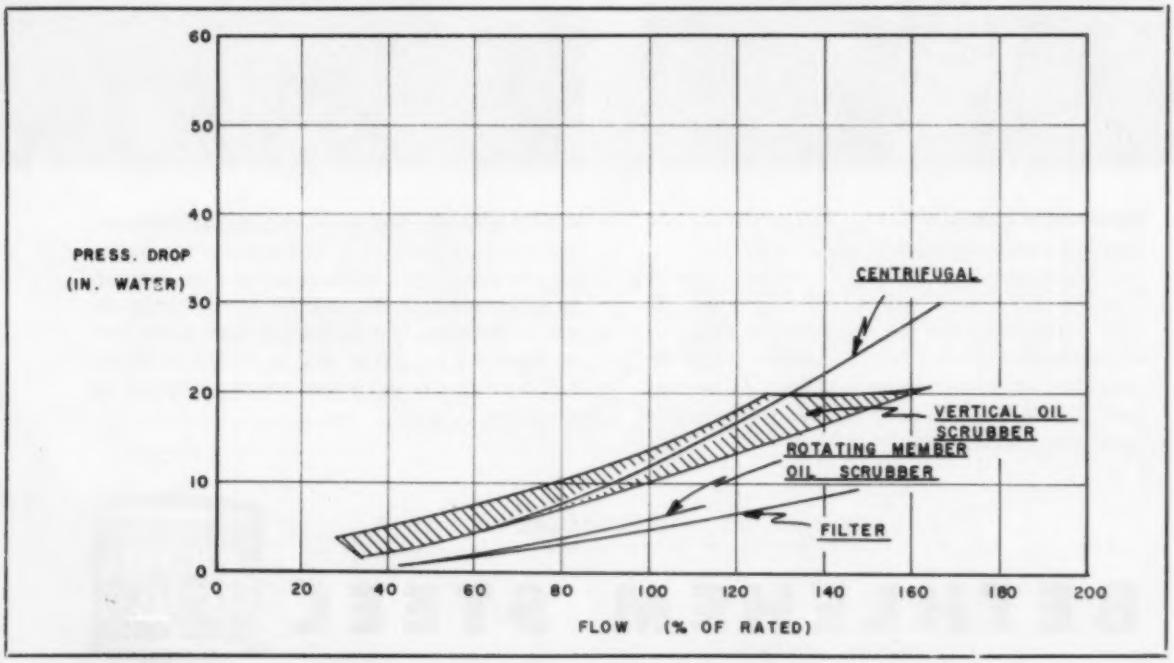

FIG. 8. Pressure drop of gas cleaners relative to flow rate.

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section is continually rotating, fresh and relatively clean surfaces of oil are always exposed to the gas. Scrubbers of this type also contain mist extractors for removal of any oil that might have been entrained with the gas.

Oil bath scrubbers are probably the most widely used type of gas cleaner in the industry. They are easy to operate, have a minimum of maintenance problems, and in general have been found to have relatively high efficiencies for removing dust. Although they are not as efficient as filters for removing small particles, they are more efficient than the centrifugal type cleaners.

Principal disadvantage of an oil bath scrubber is that it invariably loses oil. In cases where oil in the gas is objectionable, it is very often questionable whether an oil bath scrubber actually dirties the gas more than it cleans it. For example, oil losses of a few tenths of a gallon per million standard cubic feet of gas are quite normal. This corresponds to a few pounds of oil per million cubic feet. In general, the gas in a transmission or distribution system contains very much less than this quantity of suspended dust. When comparing a conventional or vertical oil bath scrubber to an oil bath scrubber with a rotating member, the principal difference in performance that we have been able to observe is that the latter type operates with a lower pressure drop.

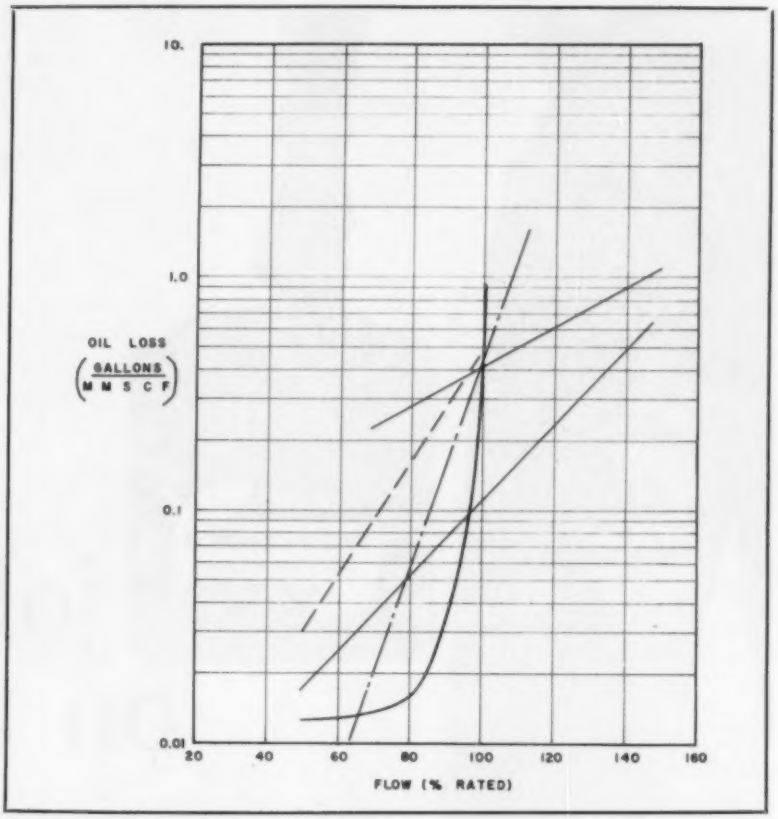

FIG. 9. Oil loss versus flow for oil bath scrubbers.

Cleaner Efficiencies

Of considerable interest are some of the experimental results obtained in the project test program, with the bulk of the work done at the Ellwood City Compressor Station of the Manufacturers Light and Heat Company. Six different cleaners were tested at this site. In addition two cleaners were field tested at the Quigley Station of the Southern California Gas Company and at the Irving Station of the Lone Star Gas Company.

Fig. 7 is a graph indicating the cleaning efficiency of the various cleaner types for different size particles. The filter tested was effective for the removal of all particles down to 0.4 microns. Efficiency for cleaning was in excess of 98 percent for all of the tests that were made. It should be recalled that the efficiency of a filter is determined by the filter medium and the results are indicative of what can be done. This does not mean that all filters can be expected to behave in this manner.

Performance of the centrifugal type separator tested was quite different from that of the filter. As can be seen, the efficiency becomes quite good for particles larger than approximately 4

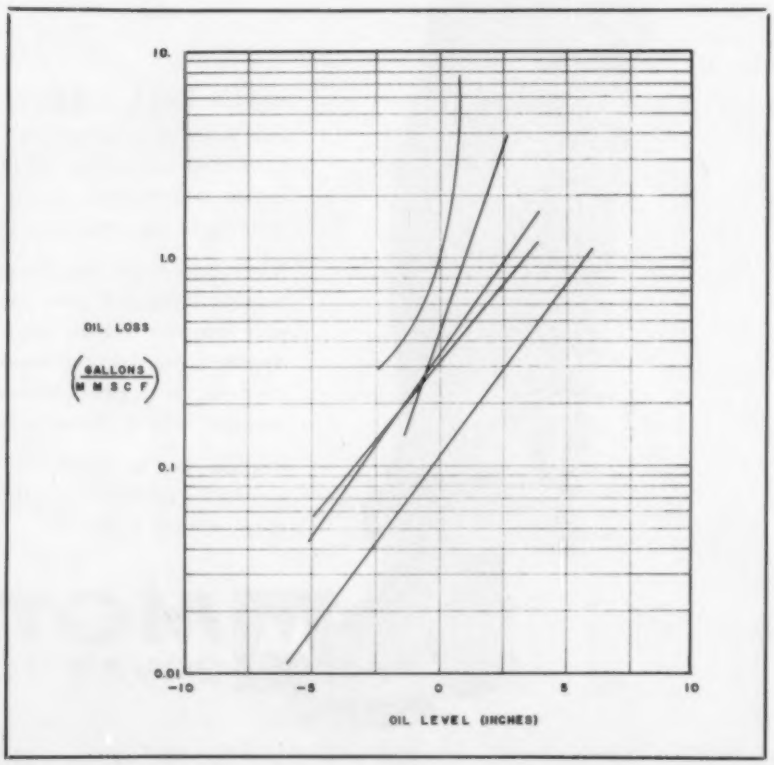

FIG. 10. Oil loss versus oil level for oil bath scrubbers.

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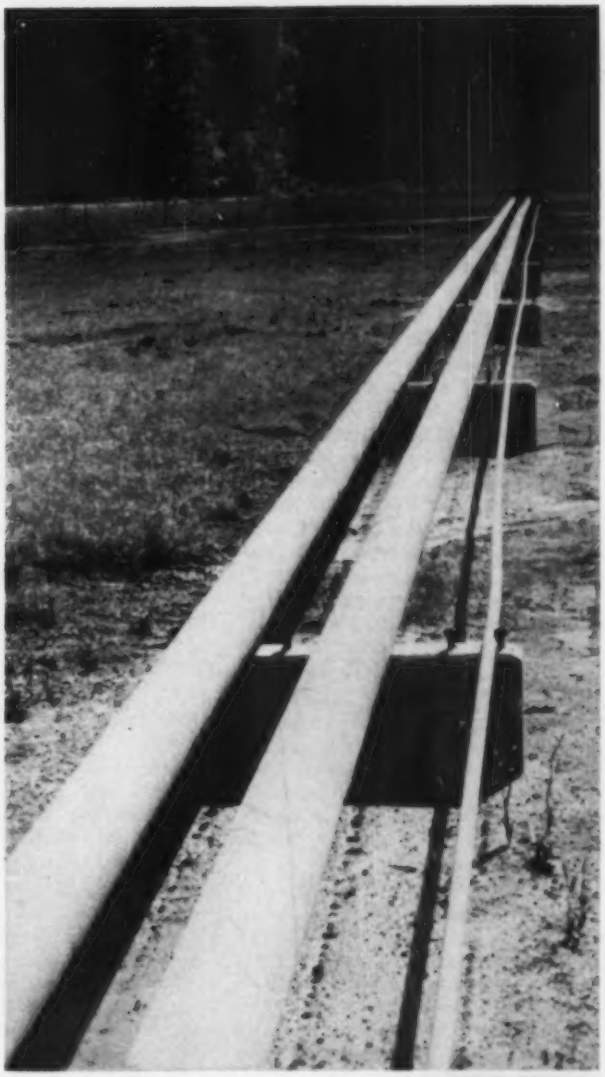

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to 5 microns. For the smaller particles, however, the efficiency decreased appreciably. This is in accord with theoretical expectations.

Negative efficiencies reported for the small particles were referred to previously. We ascribe it to deagglomeration in the cleaner of small particle aggregates. In other words, when agglomerates entered the cleaner, they were broken up into small particles that the cleaner could not remove. Thus we observed more small particles coming out of the cleaner than we observed entering the cleaner.

The middle band indicates the range of performance for the different oil bath scrubbers. These results are for conventional scrubbers as well as those with rotating members. In general, the performance of all the oil bath scrubbers was quite similar. The efficiency for particles of approximately 0.4 microns in diameter ranged from 70 to 95 percent. For particles larger than 4 to 6 microns, the efficiencies of almost all the scrubbers are in excess of 95 percent.

Data plotted in Fig. 7 is for the manufacturers' rated capacity for the scrubber. In general, the behavior did not depend to any significant extent upon the flow rate through the scrubber. Similarly, the cleaning efficiency was relatively independent of the oil level in the scrubber.

Pressure Drop Tests

Fig. 8 gives a summary of the pressure drop measurements. In this graph, the pressure drop is plotted against flow through the cleaner. The conventional oil bath scrubbers operated with approximately the same power loss or pressure drop. The centrifugal separator fell right in with the conventional oil bath scrubbers. The pressure drop through the filter was less. Data plotted here, however, is with a new filter. After the filter became loaded with approximately one to two pounds of dust per square foot of filtering area, the pressure drop through the filter was significantly greater than through the other cleaners.

Pressure drop through the oil bath scrubbers containing rotating members was also low compared to the conventional oil bath scrubbers. This is presumably due to the fact that in such scrubbers the gas does not have to support a column of oil as it does in the conventional oil bath scrubber.

Oil Losses

Fig. 9 provides a summary of the oil loss data. In this graph we have plotted oil loss in gallons per million standard cubic feet along the vertical axis versus flow rate through the cleaner as percent of the manufacturers' rated flow for the cleaner.

This data is for the cleaner operating with the manufacturer's recommended oil level in the cleaner. Note that the oil loss is plotted on a logarithmic scale. The straight lines are for the conventional scrubbers, whereas the curved line is for one of the scrubbers with a rotating member. The other such scrubber is not shown here. However, it also gave a straight line when plotted in this manner.

There are a number of points of interest with regard to this data. In all cases except one, a plot of the logarithm of the oil loss against the flow gives a straight line. There is no theoretical justification for this behavior, and we don't have any explanation for it. This is a very convenient method for plotting the data and extrapolating oil losses, however, for various flow conditions through the cleaner. It may be noted that there is a considerable difference in the behavior of the cleaners that were tested. The actual amount of oil that was lost at the manufacturer's rated capacity for the cleaner varied over approximately a 10-fold range.

The slopes of these curves also vary considerably. Actually, a flat curve is most desirable. Under these conditions, the oil loss would not change appreciably with changing flow through the cleaner.

Data for oil loss versus oil level in the cleaner is given in Fig. 10, where we have again plotted the oil loss on a logarithmic scale. The oil level in the cleaner is given as *inches of oil above or below the manufacturer's recommended oil level*. Once more the straight lines are for the conventional cleaners and the curved line is for the oil bath scrubber with a rotating member. Again we see that, in the case of the conventional cleaners, we obtained a linear plot of oil loss versus oil level. Here it can be seen that the oil loss depends very markedly upon the oil level.

It should be recalled that the collection efficiency for particles was relatively insensitive to the oil level within the cleaner. On the basis of these results, we would suggest that the manufacturer's rated oil levels are generally too high. In other words, oil loss in any particular cleaner could be minimized by decreasing the oil level within the cleaner. Furthermore, this should not effect the overall efficiency of the scrubber for cleaning the gas.

Negative Oil Loss Phenomenon

Oil loss from an oil bath scrubber can be a very subtle phenomenon. For example, in the initial work at Ellwood City, we attempted to determine the oil loss by observing the quantity of oil remaining in the cleaner after a specific period of operation.

In many instances, negative oil losses were observed. That is, during the time we were making our measurements the cleaner actually picked up oil. We have heard of other similar experiences. This raises a very interesting point: *If a transmission line contains suspended oil particles, an oil bath cleaner eventually will equilibrate itself so that there will be no change in oil level in the cleaner.* If the rate at which oil enters the cleaner from the gas stream is greater than the rate at which the cleaner would normally lose oil, the oil level in the cleaner will rise. As we can see from these curves, as the oil level rises the rate of oil loss increases. Eventually, the rate at which oil is lost will be precisely equal to the rate at which it is gained from the incoming gas. Conversely, if the rate at which oil in the gas enters the cleaner is less than the rate at which the scrubber loses oil, the oil level will fall. This will be accompanied by a decrease in the rate at which oil is lost from the cleaner. Again, the system will equilibrate in such a manner that the rate at which oil enters the cleaner is the same as the rate at which it is lost.

The significant point to be made from this argument is that oil losses must not be determined by the amount of oil which is added to a cleaner. In the long run, oil losses as determined by the quantity of oil added will be very small. This means, in effect, that the cleaner is not removing oil particles that are carried to it and that these oil particles are transmitted through the cleaner as if it were just another section of pipe.

Acknowledgments

The authors gratefully acknowledge the assistance afforded them and the research program by A. B. Lauderbaugh of Manufacturers Light and Heat Company; T. S. Bacon of Lone Star Gas Company, and L. Oberseider and J. Powell of Southern California Gas Company. Particular appreciation is expressed to Al Lauderbaugh for his cooperation and assistance during the test program at the Ellwood City station of Manufacturers Light and Heat, where six different cleaners were tested and procedures established that were later used in field testing cleaners at Lone Star Gas Company and Southern California Gas Company.

This article developed from a report presented at the A.G.A. Chemical, Engineering, and Production Conference in Rochester, New York. ★ ★

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Control of Surges in Liquid Pipelines

PIPELINE SURGES are pressure waves that increase or decrease the line pressure from the normal operating pressure at a particular location. The pressure change normally is a small percentage of the allowable working pressure but may be as much as 30 percent. In the design of pipelines and pipeline pump stations, consideration must be given to the possibility of surges occurring. These data on the control of surges deal with the practical aspects rather than the theoretical and are intended as a guide to those who might encounter surge conditions in a petroleum pipeline system.

Methods of Determining Magnitude of Pressure Surges

The fundamental formula for calculating the initial value of a surge due to an instantaneous change in the liquid velocity is:

$$P = w\,a\,V/144\,g$$

Where:

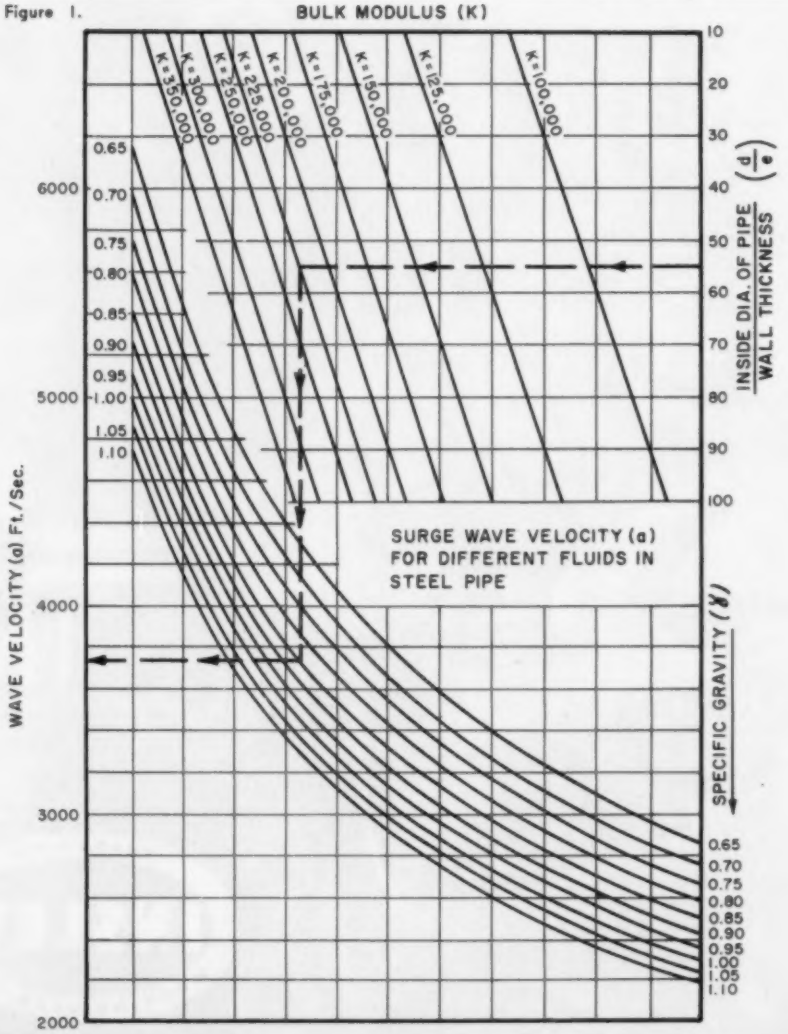
- P = psi at point of instantaneous stoppage of flow
- w = weight of liquid, lb/cu ft
- g = 32.2 ft/sec/sec
- V = change in liquid velocity, ft/sec
- a = velocity of the pressure wave front,

$$\text{ft/sec} = 12\left(\frac{g}{w}\times\frac{1}{\frac{1}{k}+\frac{D}{bE}}\right)^{\frac{1}{2}}$$

- k = fluid bulk modulus, psi
- D = outside diameter of pipe, in.
- b = pipe wall thickness, in.
- E = modulus of elasticity of pipe wall material, psi

The difficulty in using the above formula is determining

Figure 1.



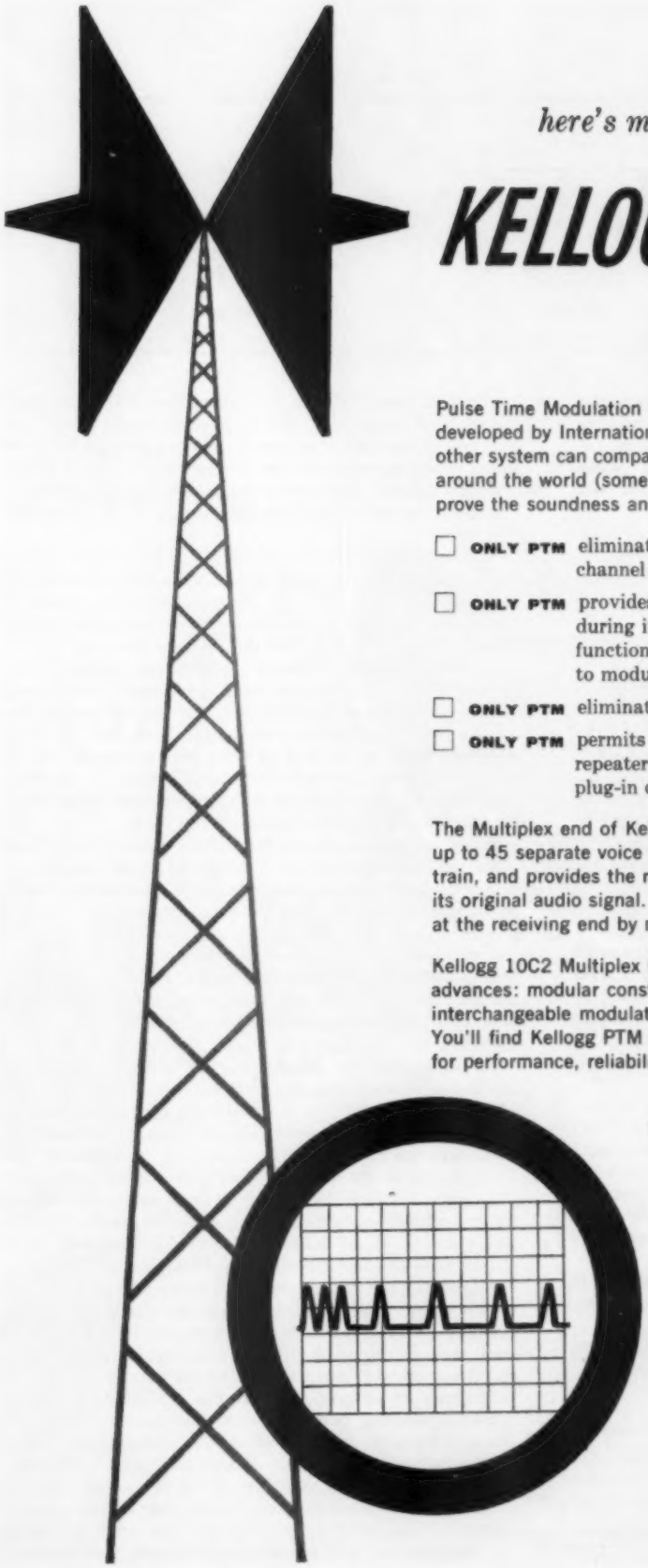


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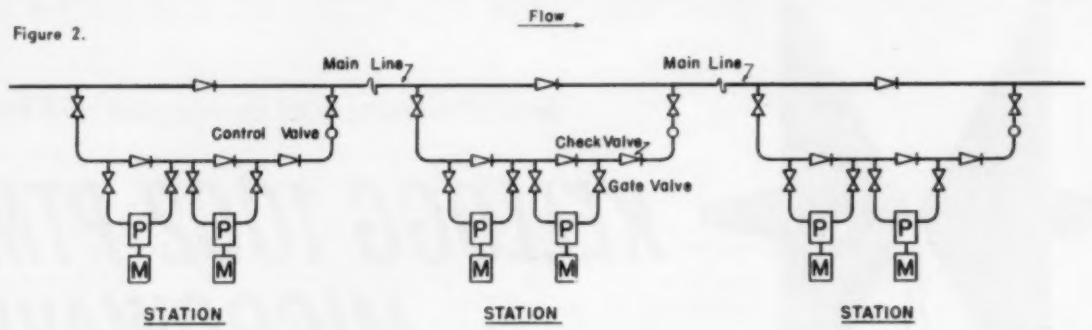
Figure 2.



the fluid bulk modulus, "k", which is different for each type of liquid and varies with temperature, pressure, and, in some liquids, length of time under pressure. As an indication of the variation among liquids, the average "k" value at 60 F and 600 psi for gasoline is 155,000 psi; for McCamey crude (25 deg API), 250,000 psi.

Fig. 1, which may be found in the "Final Report of Joint Surge Conference,"[1] is included here for quick approximation of the wave velocity "a." As a rough estimation of the initial surge, a value of 40 psi per ft per sec change in velocity may be used for products and 50 psi for crude. These values generally will be higher than those actually encountered in a pipeline.

To determine the magnitude of a pressure surge at points along the pipeline, it is necessary to employ the graphical method given in the "Final Report of the Joint Surge Conference" and in "Hydraulics for Pipeliners" by C. B. Lester. The graphical method must be used because the pressure wave is somewhat dampened by friction, fluid compression, and pipe expansion, the relative effects of which cannot be estimated. The combined effect of fluid compression and pipe expansion is commonly termed the "Capacitance Effect" of a pipeline.

General Discussion

The common practice of designing cross country main lines with maximum working pressures of 65 to 72 percent of minimum yield with allowances for corrosion and pipe wall thickness reduces the need for special consideration to surges. In grade or wall tapered lines, however, an allowance of 40 psi should be made for each ft per sec change in velocity for maximum protection.

In station design, devices such as pressure controllers, pump shut-down switches, or relief valves are mandatory for the protection of the main line and station equipment. When two or more centrifugal pump stations are boosting on a closed system and the flow is blocked, the line pressure equals the sum of the pump shutoff pressures, whereas with reciprocating pump stations, the pressure increases until either the pump or pipe fails.

Short lines and associated pumping equipment should be given special consideration due to resonance in the system and a minimum dampening effect.

Entrapped air in pipelines when either filling a new line or after major repairs in an existing line, although not a design problem, creates an operational hazard.

Protective Devices for Centrifugal Pump Stations

Pressure surges occur in a pipeline with centrifugal pump stations when a downstream station is suddenly shut down. (See Fig. 2.) The check valve on the discharge side of the station will close, causing an instantaneous flow stoppage and pressure surge. Since this surge occurs on the low pressure end of the line, the pipe normally can withstand the added strain; however, as the pressure wave travels to the upstream station, excessive internal pressure may be created. Normally, in long lines, the pressure wave is somewhat dampened.

A usual feature in station design is a discharge pressure controller, which will either reduce the speed of the pump or close a control valve. A pressure shutdown switch is commonly used in conjunction with the controller to shut down the station in the event the pressure increases beyond the controller limits. Pressure switches are extremely important when two or more stations are boosting on a closed system. If the controllers do not immediately reduce the speed of the pumps to approximately 1/N of their operating pressure (N = the number of units pumping in series), or prevent the pump pressure from being applied to the main line, it is very likely that the additive pressures would burst the pipeline if pressure switches are not used.

When surges are caused by sudden closure of a check valve, the discharge pressure is decreased on the downstream side of the valve and the suction pressure is initially increased by an equivalent amount. As the surge travels away, pressure is built up until the valve opens, and flow will resume past the shutdown station. On most pipelines the stations are hydraulically balanced and the check valve will open before the pressure wave has had time to be reflected from the next upstream station, preventing further station pressure build-up.

In any system it is possible to close a valve unintentionally and completely stop flow, and this is most likely to occur when switching the flow from one storage tank to another at a delivery point. A rapid calculation of 50 psi times the maximum velocity ft per sec in a crude pipeline will give a rough idea of the surge intensity that may be anticipated. This value added to the hydraulic gradient should indicate the magnitude of pressure that might be encountered at any location. If an excessive pressure is indicated, relief valves should be installed on the delivery end of the system.

Sometimes the critical area for a surge may be tank farm piping where lines and fittings are not designed for high pressure. When a pressure wave from the main line travels back through the pump it could cause pressure rises above the designed working pressures of the fittings or pipe. In long crude oil or products lines this is unlikely to happen due to dampening effects. In short lines such as those used for tank truck or tank car loading where quick shutoff valves are employed, this possibility should be given consideration. As an example, where velocities of 7 ft per sec are encountered, it is possible to create an approximate 300 psi pressure rise by a rapid valve closure. As most low pressure systems are designed for 230 psi working pressure, it is necessary

[1] "Final Report of Joint Surge Conference" sponsored by: Middle East Pipe Lines, Ltd., Trans-Arabian Pipe Line Company, and Gulf-Shell Pipe Line.

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to employ some method of surge control, such as installation of slow closing valves, surge chambers, or automatic loading devices. The use of larger lines to decrease the velocity would be helpful.

Protective Devices for Reciprocating Pump Stations

The two problems to be considered when reciprocating pumps are employed are the effects of surges traveling to an upstream station and the pulsations or surges usually found in the station piping.

Where a reciprocating pump station pumps to a booster station, a surge can be created by a sudden shut down of the booster station or flow blockage. When the pressure wave reaches the reciprocating pump station, it is reflected by a much higher pressure than encountered with centrifugal pumps, unless proper safety devices are provided. If there are no pressure controlling or limiting devices, the line pressure may be great enough to burst the pipe or damage the pump. Protective devices normally included in the design consist of a pressure controller operating either a throttling bypass valve or the pump stroke or speed. As an added precaution, it is highly recommended that a relief valve be installed that has a capacity equal to the maximum pumping capacity. The relief valve should be of the manual reset type to permit proper corrective measures to be taken before resuming normal operations. If an automatic reset type is used, a high pressure switch also should be employed to shut down the pumping equipment. This is important for the relief valve of this type could open and close repeatedly, surging the line with each action.

Should there be only one relief valve for a number of pumps, the relief line should have the same pressure and capacity design as the main line. Preferably, the relief valve should discharge into a tank through a separate empty line with no bends or turns. The line should be designed so that it will drain completely, since a partially filled relief line seems to have even worse effects than a full line. Tying in the relief line to the pump suction line should be discouraged because complete reversal of flow creates a high surge pressure.

Another point for consideration is the effect of reciprocating pumps on discharge piping. In the past, many pipeline companies have experienced failure in discharge lines when the mean pressure from the pumps was well below the designed pipe working pressure. Tests showed that most of the failures were caused by pump impulses that were in resonance with the discharge piping. This meant that somewhere in the piping there was a high pressure reflection of the pulses and that these reflections came back at the same time the pump was creating another pressure wave.

Usually these reflections came from a tee or from a change in pipe diameter. As an illustration, assume that a duplex double acting plunger pump is 500 ft from a tee in the station manifold. If a pressure wave travels 4000 ft per sec in crude oil, then a high pressure pulsation from the pump would return from the tee back to the pump in ½ sec. If the pump were running at 30 rpm, extremely high pressure surges would be created, but if the speed were increased to 60 rpm there would be no surge due to resonance. Since 30 rpm is the resonant speed, all even multiples of this would be free of surges.

The problem of dampening resonant surges can be solved in different ways depending on the pump speed and discharge pressure. In stations where two or more units are installed, the pulsations may be dampened by tying all the pump discharge lines together a short distance from the pump headers with an equalizer line or by the use of properly sized air chambers. In pumps operating at 20 cps or less and below 900 psi, the pressure swing has been reduced by these methods by as much as 90 percent, which is within tolerable limits when piping is buried or well supported.

On high speed multiplex pumps operating at more than 20 cps and above 900 psi pressure, it has been found that air chambers and equalizer lines will not adequately suppress the resonant pump surges. Pulsation dampeners of special design have been found to be satisfactory in coping with high frequency pressure surges.[2]

In the design of high speed pumps, many factors become critical and should be given careful consideration to eliminate surges. One such factor is the valve design and loading and, unless some previous experience indicates what to use, the proper valves should be selected in the field by trial and error methods. Another item to be considered in the design of high capacity equipment is the piping to and from the pump. This piping should balance the load on the suction and discharge valves so that plungers will be loaded equally. All station piping should be streamlined and contain no sharp bends.

Resonant impulses in suction piping have been omitted purposely because they rarely present any serious problem.

Pressure Surges Due to Air and Voids

Air entrapped in petroleum pipelines during test or following major repairs has always been a source of concern because of the possibility of surges of high magnitude. In addition air in the line during testing lengthens the time necessary to attain a desired pressure and could cause considerable damage, due to its stored-up potential energy, should the line burst. It also causes pressure fluctuations, making it difficult to detect leaks. In hilly terrain, air pockets at the high points have made it impossible to fill a line at designed working pressure until the air has been bled-off at critical points. This phenomenon can be understood if one imagines that the line on the downstream side of a hill contains air and the next hill is exerting a static pressure to keep the air confined. If this situation were multiplied by a number of hills, it would be theoretically possible to have a line pressure at the filling point equal to the sum of the static pressures of the individual hills.

Air is best eliminated in hydrostatic testing by running plug type scrapers during the line filling, bleeding off the air at the high points, and holding a back pressure to keep the line packed behind the scraper. To prevent voids when displacing water, plug type scrapers should precede the petroleum liquid and suitable back pressures maintained. Voids present a greater potential danger than air because a surge is inevitable and its magnitude can not be predicted.

With air pockets in a petroleum pipeline, there is constant danger of an explosion due to an ignition from a scraper or other causes. Should an explosion occur, sympathetic detonation of other air pockets may cause line ruptures. As no actual tests have been conducted there are different theories as to what happens in such instances. One theory is that the line is ruptured by severe pressure waves created when two liquid columns meet in a voided line. Another theory is that a large slug of air is forced from one hill to another, causing sudden changes of velocity with resultant high pressure waves.

Although it is generally accepted that air tends to cushion pressure waves and may be absorbed by the flowing liquid, precautions should be taken against the potential hazards expressed by these theories. These precautions include operating at reduced flow rates and suitable back pressures until all air is eliminated from the system.

Pipeline surges, whether caused by improper design or operations, cannot be overlooked. The reference material mentioned here treats pressure surge theories in considerable detail and is recommended for those interested in technical aspects.

[2]M. Ludwig, "Design of Pulsation Dampeners for High Speed Reciprocating Pumps," API Division of Transportation Conference, May 1956, Houston, Texas.

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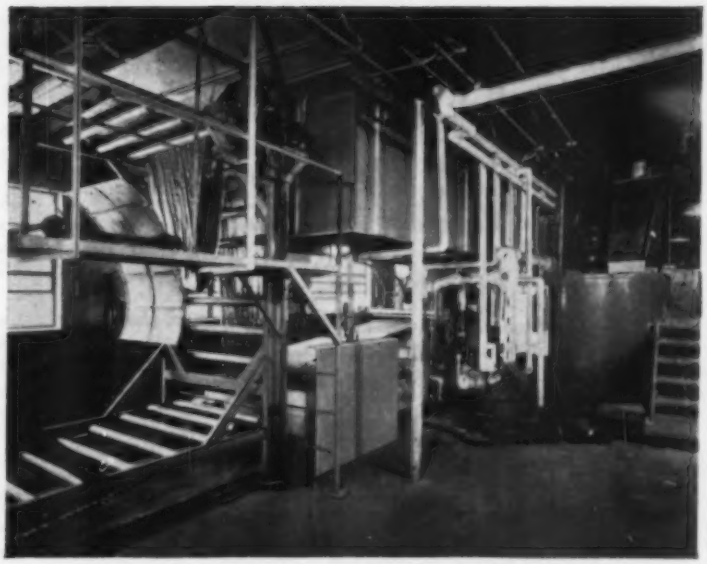

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Pipeline Projects

California PUC Hears TGT Plans To Serve Edison Through Mexico

$160,000,000, 1200-Mile, 34-In. Line Proposed

A Tennessee Gas Transmission Company senior vice president has testified before California Public Utilities Commission that his company is negotiating with Southern California Edison Company to provide Edison with a large independent supply of boiler-fuel gas which would come mostly from U. S. territory on the Gulf of Mexico through a 1200-mile, 34-in. pipeline that would be constructed through Mexico at a cost of approximately $160,000,000.

Pacific Lighting Gas Supply Company has stated that it "would oppose with all vigor — and at every opportunity — any attempt by Southern California Edison to gain an independent, out-of-state gas supply for use under its steam plant boilers."

William W. Witmer, TGT senior vice president, testifying that gas deliveries are expected to start in July 1962, said that no definite contract has been signed yet. The proposal is that Edison would pay approximately 42 cents per Mcf at the California-Mexico border with no rate increase for 20 years, other than known escalations in gas purchase contracts.

Petroleos Mexicanos has confirmed that an initial working agreement has been signed with TGT for preliminary negotiations to build a pipeline linking Reynosa on the Texas border with Mexicali in Lower California.

The Mexican portion of the line would be owned and operated by Pemex but serviced and maintained by TGT. It would carry volumes of 335,000,000 cu ft per day from U. S. sources plus a minimum of 75,000,000 daily from Mexico. Quantities of Mexican source gas could rise to 200,000,000 cu ft, Witmer testified. There is the possibility of additional Mexican gas being delivered to Mexican industries along the way.

TGT is negotiating with Edison to take 250,000,000 cu ft a day for the first year with a buildup to 410,000,000 cu ft in the fifth year. If Edison does not want all the gas, TGT would offer it to other firms in southern California.

FPC Further Conditions Producers Involved In $74,639,000 Facilities

Natural, Peoples Gulf Coast File New Projects

The Federal Power Commission has placed a new condition on a group of independent producers involved in a recent authorization to Peoples Gulf Coast Natural Gas Pipeline Company and Natural Gas Pipeline Company of America to build a total of 758 miles of pipeline.

Seven independent producers proposing to sell gas to Peoples Gulf Coast from fields in Aransas, Brazoria, Calhoun, and Galveston counties, Texas, proposed an initial price of 20 cents per Mcf with 2-cent escalations every four years until a price of 28 cents would be reached, only to have the FPC condition them to an initial price of 20 cents with a 3-cent escalation after ten years. The FPC not only denied a rehearing request, but now has amended the earlier order to reduce the price of the Aransas and Calhoun counties gas from 20 to 18 cents, but with no modification of escalation provisions.

Peoples Gulf Coast will increase its daily design capacity by 85,000,000 cu ft with construction of 371 miles of 30-in. parallel line, 56 miles of supply lines, purchase meters, and a 6700-hp compressor station, at a cost of $43,451,000 — as soon as the producers have accepted their FPC certificates.

Federal Power Commission hearings begin September 26 on the application of Natural Gas Pipeline Company of America to acquire and operate the pipeline system of its affiliate, Peoples Gulf Coast Natural Gas Pipeline Company.

Natural plans to continue rendering Gulf Coast's services at the same rates now in effect, but said it plans later to file a single tariff applicable to all sales by both companies.

Natural already has started construction of 151 miles of 36-in. loop line between compressor station No. 103 and Joliet, Illinois, 180 miles of 24-in. between station No. 103 and station No. 156 in Kiowa County, Oklahoma, and additional metering and regulating facilities, at a cost of $31,188,000, to increase its daily design capacity by 100,000,000 cu ft.

Even as Natural's project gets underway, the parent company, Peoples Gas Light and Coke Company, has announced filing with the FPC new projects that will expand Natural's daily deliverability by another 40,000,000 cu ft and Peoples Gulf Coast by another 60,000,000 cu ft. The former would involve construction of 62 miles of pipeline and various river crossings, and the latter construction of 27 miles of pipeline and supercharging of 71 compressor stations.

FPC Aide Approves $57,000,000 Projects

A recently-filed Federal Power Commission examiner's decision approves more than $57,000,000 in construction by four natural gas pipeline companies —principally Texas Eastern Transmission Corporation and its proposal to make a total maximum of 334,036,000 cu ft per day available to 23 wholesale customers in the Midwest and east.

Other companies affected by the decision are Algonquin Gas Transmission Company, Transcontinental Gas Pipe Line Corporation, and New York State Natural Gas Corporation.

Texas Eastern will construct about 214 miles of 20 to 36-in. pipeline in Pennsylvania, New Jersey, and New York, and a new 3300 hp compressor station, at a cost of about $40,668,000, and jointly develop with Transco and New York Natural its share of the Leidy storage field. This development, estimated to cost $8,022,400, is required for Texas Eastern to carry out this new winter service plan. The cost will be shared with Transco.

Algonquin will build about 30 miles of pipeline and 8000 hp in compressor capacity at a cost of $5,502,200 to transport and sell 75,130,000 cu ft of winter service gas to be received from Texas Eastern—a service that has been made for the last two years under temporary FPC authorization.

Transco will construct a 6000-hp compressor station in Pennsylvania, at a cost of about $2,995,000, to enable it to fulfill its delivery obligations in the storage area after Texas Eastern's share of the Leidy field is developed.

Texas Eastern and Transco each have one-quarter interests in the Leidy field, with New York Natural holding the remaining half interest. Development of Transco's share of the top storage capacity previously was approved by the FPC.

Presiding Examiner Emery J. Woodall's decision also permits Texas Eastern to sell up to 20 billion cu ft of gas per year jointly to four subsidiary companies of the Consolidated Natural Gas System—East Ohio Gas Company, Peoples Natural Gas Company, New York State Natural Gas Corporation, and Hope Natural Gas Company.

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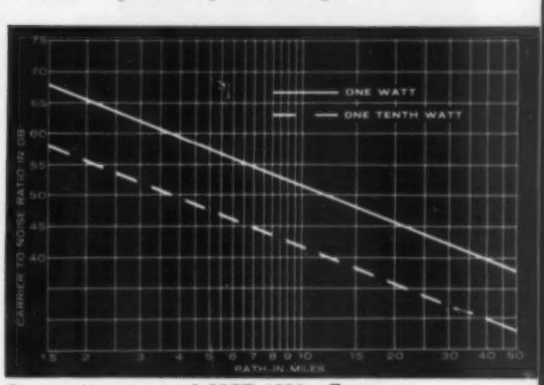

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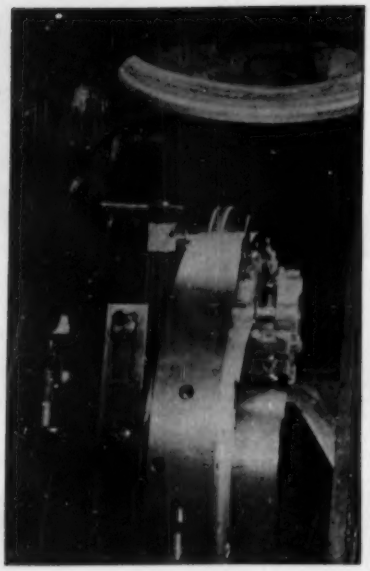

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PIPELINE PROJECTS

FPC Aide Approves Rock Springs Project

CIG Follows With Another Filing For Wyoming Station

A Federal Power Commission examiner has approved the El Paso-Colorado Interstate Rock Springs project that will involve the construction of over 1000 miles of pipeline and supply southern California with an additional 470,000,000 cu ft of natural gas per day.

Colorado Interstate Gas Company would build a 155-mile, 34-in. line from Rock Springs, Wyoming, to Provo, near Salt Lake City, Utah, where it would connect with a 394-mile, 34-in. line to be built by El Paso Natural Gas Company, extending to the California-Nevada border near Las Vegas. The gas would be delivered at that point into a 92-mile, 34-in. line proposed by Southern California and Southern Counties Gas companies.

El Paso's Provo-Las Vegas line would include a 7200-hp compressor station. El Paso's new facilities would cost $58,685,000.

Colorado Interstate, proposing to spend $92,829,566, also would build 476 miles of line and install 83,880-hp in compressor capacity at new and existing stations to strengthen its existing system to provide increased and more efficient service to customers in the Rocky Mountain area.

Colorado Interstate, since the decision was filed, has already filed another application with the FPC for a temporary certificate to build a 4500-hp compressor station at Rawlins, Wyoming, on the company's Green River-Denver transmission line, at an estimated cost of $1,750,000.

Colorado Interestate plans to retire about 245 miles of its original Amarillo-Denver pipeline, north of Clayton, New Mexico, and seven compressor stations along the line, following completion of its proposed expansion.

Fall Plans Shape As Texas Gas Gets OK

Texas Gas Transmission Corporation has received Federal Power Commission authority to construct 24 miles of 30-in. pipeline in three segments between Bastrop and Eunice, Louisiana, and 56 miles of 12-in. from Wilfred Storage Field to Bedford, Indiana.

Right-of-way has been obtained for the 30-in. construction, and clearing and grading will begin in the northern segment near Monroe, Louisiana, in September. Construction of the segment of 30-in. south of Columbia compressor station, and the segment north of Eunice, will be delayed until the rice harvest in fields through which the pipeline must pass. The 30-in. construction should be completed early in November, says a company source.

The Indiana construction will begin in early September, with completion anticipated by the middle of November.

Compressor horsepower additions—2500 at Covington, Tennessee, and 2000 at Calvert City, Kentucky, are underway, but contract has not been let on 1320 and installation of turbochargers on two existing 880-hp engines at Lafayette, Louisiana.

Cost of facilities is approximately $7,936,200.

The Louisiana loops will enable the company to take an additional 70,000,000 cu ft per day, or a total of 464,200,000 cu ft daily, particularly from the Lake Arthur, E. Lake Palourde, Chacahoula, Thibodaux, and Jeanerette fields. The additional compression units will be used as spares to permit overhaul of present units. The 12-in. line in Indiana will provide flexibility to the northern portion of the system.

Drops Extension Plans

Peace River Oil Pipe Line (B.C.) Ltd., has surrendered a permit to build an oil pipeline in northeastern British Columbia which would have served local refineries and enabled surplus crude from that area to have reached Pacific Coast markets through connections with Alberta and federal pipelines.

Normal financing of the multi-million dollar project proved impossible, the company states, because of conditions which the British Columbia government attached to the permit granted last April. August 1 was deadline for start of construction.

The main obstacle was a condition which specifically provided for possible diversion of B.C. crude to any future pipeline entirely within the province. This would have left idle connecting lines required to be constructed in Alberta to provide connection with the line to Vancouver.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Temporary OK's Involve Much Line-Laying

The Federal Power Commission has granted five unrelated temporary certificates involving about 470 miles of pipeline construction.

Principal of these is to **Transwestern Pipeline Company** to construct about 250 miles of varying diameter gathering lines, three new compressor stations with a combined capacity of 8040 hp, and appurtenant equipment, at a cost of approximately $8,701,980.

The FPC, also issuing temporary authorizations to 24 independent producers covering their proposed sales to Transwestern, conditioned the temporary authorizations upon initial prices ranging from 16 to 18 cents per Mcf, consistent with its findings in authorizing construction of the company's Texas-to-California system. The producers had proposed prices ranging from 18 to 23 cents per Mcf.

Kansas-Nebraska Natural Gas Company, Inc., will extend its system in northwestern Nebraska with approximately 167 miles of 2 to 8-in. pipeline and town border stations for Chadron, Crawford, Hay Springs, Hemingford, Gordon, and Rushville, Nebraska, at an estimated cost of $1,650,000.

Mountain Fuel Supply Company plans to build about 20 miles of 20-in. loop line, replace about 7 miles of 16-in. with 24-in. and about 6 miles of 18-in. with 20-in., and build a 2640 hp compressor station, at a total cost of $3,125,000.

Hope Natural Gas Company will replace approximately 20 miles of 12-in. pipeline with 20-in. in Lewis, Ritchie, and Pleasants counties, West Virginia, at a cost of about $2,097,100, to obtain better use of the delivery capacity of the Fink-Kennedy storage pools.

El Paso Natural Gas Company plans to install an additional 6800 hp at its Goldsmith compressor station and facilities to provide an additional 58,800,000 cu ft per day capacity at its Goldsmith purification and dehydration plant. These facilities in Ector County, Texas, will cost an estimated $3,930,000.

Plantation Announces $2,000,000 Expansion

To meet present and future requirements of liquid petroleum products in the Montgomery, Alabama, area, Plantation Pipe Line Company is replacing an existing 73-mile, 4-in. pipeline between Helena and Montgomery with an 8-in. pipeline.

The new line, expected to be in operation by October, will increase the capacity to supply that area from 8300 bbl per day to 20,000 bbl per day. With pumping, metering, and filtering facilities, the project is estimated to cost $2,000,000.

$150,000,000 System Planned In South Texas

A new San Antonio, Texas, company has revealed plans to build a $150,000,000 natural gas gathering system that could send up to 150,000,000 cu ft of South Texas gas daily into the main line of Texas Eastern Transmission Corporation.

Border Gas Transmission Corporation—jointly owned by Lehman Brothers, a New York investment firm, and Rio Gas Gathering Company, headed by Kendall A. Ehman—will ask permission of the Federal Power Commission to build the system that would be from 300 to 400 miles long, extending through Webb, Zapata, Starr, Jim Hogg, Brooks, Dimmit, Zavala, Maverick, and LaSalle counties.

Hearings Set for Cities Service

The Federal Power Commission has set a September 7 hearing on two applications by Cities Service Gas Company to expend $10,492,800 on a 1960-62 expansion program.

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Internationally

A Bombay, India, pipeline connection to the Sui gas field is expected to figure into formal talks planned soon between India and Pakistan over the possibility of importing natural gas from the Sui field into India.

A Bavarian extension of the Marseille-Strasbourg-Karlsruhe pipeline will be constructed and operated by the eight German oil companies that already participate in the latter. They are: BP Benzin und Petroleum AG, Deutsche Erdol-AG, Deutsche Shell AG, Esso AG, Gelsenberg Benzin AG, Mobil Oil AG, Scholven-Chemie AG, and Wintershall AG. The 155-mile, 22-in., $23,800,000 crude oil line between Karlsruhe and Bavaria will supply the oil refineries which the companies are going to construct in Bavaria. The line's capacity will be about 29,816,000 bbl annually.

BP Trading, Ltd., has sent out to British, Continental European, and U. S. suppliers invitations to tender for supplying steel pipe to construct a concrete-encased, 20-mile submarine pipeline in the Persian Gulf. The 18-in. pipe will be used to link a crude oil collecting platform in the middle of the Umm Shaif underwater oilfield with Das Island, and 6 or 8-in. pipe will link each producing well with the collecting platform. Value of the pipe order is expected to be about $1,400,000. Special manufacturing controls will be observed to ensure only minimum attention after it is laid on the seabed.

Colombian municipality of Bucaramanga and German capitalists are reported to be financing, at a cost of $2,900,000, a products pipeline to be constructed between Barrancabermeja and Bucaramanga.

In Germany, a second natural gas pipeline to transport larger quantities of gas from the Emsland fields to the Dorsten pressure gasification plant is underway with completion scheduled by the end of the year. Erdgas-Verkauf GmbH and Ruhrgas AG will be jointly in charge of constructing the 15¾-in. line almost parallel to the existing 8-in. line. More than 35,000,000 cu ft of gas per day, including throughput of the already existing pipeline via Marl, will be supplied initially to the plant.

National Iranian Oil Company is planning to tap its Sarejeh natural gas field with an 87-mile pipeline to Teheran and has signed a contract with SNAM Progetti, one of Italy's ENI group, for a preliminary survey.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

PIPELINE PARADE

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Two top sales executives and three district and four product managers have been appointed by W-K-M division of ACF Industries, Inc. Glen Tableman, a 10-year veteran of W-K-M, was named manager-sales. Reporting to him will be: Ross Spencer, manager — Southwest district, formerly with the market research department; Gaston T. White, manager — Southeast district, formerly area supervisor for the Lafayette, Louisiana, area; and William Giffhorn, manager — Mid Continent district, formerly supervisor of sales for north Louisiana and east Texas. Paul J. Natho was named manager of the newly created market development department and working closely with him will be the following four product managers, all veteran W-K-M employees: M. J. Conley, oilfield; Paul Nerren, pipeline; Bart Braznell, refinery; and Bob Butler, industrial.

Oakite Products, Inc., manufacturers of specialized chemicals for industrial cleaning, sanitizing, and metal treating, has appointed as Detroit division manager Daniel B. Lamb, who received the company's citation for distinguished service to the industry in 1956. Lamb replaces Thomas R. Smith, who is retiring after 19 years as head of the Detroit division.

Walworth Company, reorganizing its sales department to give new emphasis to the marketing of valves, has regrouped virtually the entire general office sales unit directed by Harold Brown, vice president, sales. Reporting to Brown, and responsible for the entire operation of the new marketing department, is Sidney A. Lewis, former manager, technical sales service. Robert McNally, replacing Lewis while retaining his previous position of marine and government sales manager, will oversee the operations of the bronze, steel, iron, plastic and Walseal, and lubricated plug valve sales departments. The advertising department, under the management of Robert L. White, also will become an arm of the new marketing department.

Promotion of Joseph A. Wiendl to general manager of sales has been announced by **Ingersoll-Rand Company.** Wiendl was assistant general manager of sales and, prior to that post, manager of the rock drill department.

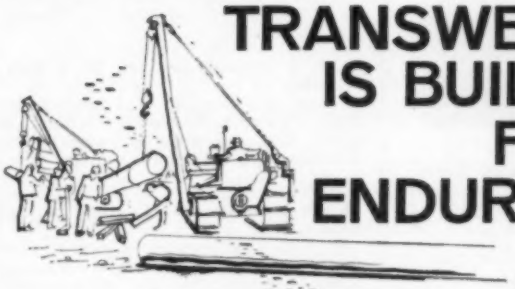
In the Houston-Corpus Christi, Texas, area, for Clark Bros. Co., one of the Dresser Industries, Stewart L. Babbitt has been named sales engineer, G. M. Woodman has been assigned to the Houston district as small engine salesman, C. R. Apitz has been assigned to the Houston office as senior sales engineer, and F. J. Shaw was named sales engineer for the Corpus Christi area. Babbitt formerly was service manager in Houston; Woodman was small engine salesman for the Corpus Christi area; Apitz was special representative, gas turbines, Dallas, Texas; and Shaw was application engineer in Houston.

In new West Coast sales appointments, Clark announces that James H. Bews, who was sales engineer at the Los Angeles district office, is now manager of its San Francisco branch office; and that Hugh R. Lafferty, formerly application engineer in Los Angeles, has been named sales engineer for the same area.

A 20-year veteran of engineering and marketing, John H. Newitt, has been appointed sales engineer for the Texas division of the **Collins Radio Company** in the New England area.

As part of its fast-growing expansion program overseas, Grove Valve and Regulator Company has licensed two additional European firms to produce G-4 gate valves that are used to control flow of natural gas and petroleum in pipelines. The new licensees are **Nuovo Pignone** of Firenze, Italy, and **Robert Cort & Son, Ltd.,** of Reading, England. Grove's French subsidiary, Grove France S.A., Paris, has been producing G-4 gate valves since early in 1958.

Spotlighted at the 1960 sales meeting of Midwest Piping Company, Inc., St Louis, Missouri, was the company's double line of welding fittings—seamless type and welded type—production of which was begun early this year. More than 50 persons attending heard Dan H. Barr, director of vendor product sales, Oil Well Supply Division, U. S. Steel Corporation, a leading distributor of Midwest fittings, discuss distributor-manufacturer relationships.



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The Transwestern Pipeline Company line, with 1600 miles under construction from Fort Stockton, Texas and the Texas Panhandle to near Needles, California, will serve West Coast consumers with natural gas for many, many years to come. Its underground lines and structures are being installed with coal-tar enamel coating for high integrity electrical insulation and life-long corrosion protection. Reilly Hot Service Enamel with HS X-10 Primer and Reilly Intermediate Enamel with Q.D. Primer have been specified along with Coal Tar Enamels of other manufacturers and will serve as the engineering material of choice for corrosion mitigation.

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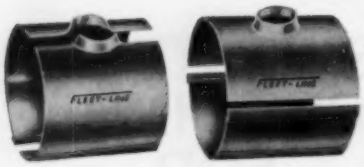

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WITH THE PIPELINE CONTRACTORS

● **Banister Construction Co. Ltd., 625 Northern Hardware Bldg., Edmonton, Alberta, Canada.**

Producers Pipelines, Ltd. — undetermined amount of 3, 4, and 6-in. crude oil gathering system in the Estevan, Saskatchewan, area. Field superintendent: Basil Seemann. Foremen: Steve Slade, D. Gooderick, Joe Schmidt.

Saskatchewan Power Corp.—25 miles of 4-in. in Saskatchewan from Canora to Kamsack and 35 miles of 4-in. from Tisdale to Nipawin, with a 20-mile, 4-in. lateral to Carrot River.

● **Bechtel Corp., 220 Bush St., San Francisco 4, California.**

Midwestern Gas Transmission Co.—75 miles of 24-in. in Minnesota from Becker Clay County line to Euclid, with field office at Ada and M. A. Finnerty as superintendent. Also, 79 miles of 24-in. from Euclid to the Canadian border, with field office at Hallock and M. A. Roberts as superintendent.

Michigan Wisconsin Pipe Line Co.—84 miles of 24-in. between the Mississippi River and Sandwich, Illinois.

Esso Standard (Libya) Inc.—a 100-mile, 30-in. crude oil pipeline from the Zelten field in Libya, north to Marsa el Brega on the Gulf of Sirte.

● **Bristow-Hyde Engineering Corp., First City National Bank Bldg., Houston, Texas.**

Midwestern Gas Transmission Co.—39 miles of laterals in connection with the company's 504-mile, 24-in. pipeline from the Canadian border.

● **O. R. Burden Construction Corp., Box 5216, Tulsa, Oklahoma.**

Natural Gas Pipeline Co. of America—58 miles of 36-in. in the vicinity of Concordia and Ford, Kansas. R. M. Jones is supervising. Field office: Glasco, Kansas.

Peoples Gulf Coast Natural Gas Pipeline Co.—37 miles of 30-in. in Wharton County, Texas.

● **W. E. Claycomb and Son, Rt. 1, Cody, Wyoming.**

Husky Pipeline Co. — a 96-mile line from Husky Oil Company's refinery at Cody, Wyoming, to a connection with Yellowstone Pipe Line at Billings, Montana.

● **Collins Construction Co., Box 86, Port Lavaca, Texas.**

Petroleos Mexicanos — dual 12 and 24-in. natural gas pipeline river crossings between Pemex City and Mexico City, Mexico. Tom Broom is supervising.

British Petroleum Co., Ltd. and *Iraq Petroleum Co., Ltd.*—20 miles of dual 32-in. pipeline from Fao, Iraq, to an artificial offshore island in the Persian Gulf. Project manager: Harry Frankman.

● **Contracting and Material Co., 1235 Dodge Ave., Evanston, Illinois.**

Midwestern Gas Transmission Co.—54 miles of 24-in. from Wanderoos, Wisconsin, to the Chippewa River, near Eau Claire. Field office: Amery, Wisconsin. Superintendents: A. J. Fry and J. H. McGill.

● **D. Michael Curran & Co., Eklund Bldg. Great Falls, Montana.**

Cenex Pipeline Co.—an 8-in. products pipeline in Montana and North Dakota. This is a joint contract with C. E. Wilson Construction Co.

● **Fowler-Tatom, Pipeline Contractor, Inc., Jasper, Texas.**

United Gas Pipe Line Co.—8 miles of 30-in. at the McGee Bend reservoir near Jasper, Texas. Superintendent: John E. Allen. Office manager: W. G. Barnette.

● **Fulghum Contracting Corp., Box 1181, Harrisburg, Pennsylvania.**

Transcontinental Gas Pipe Line Corp.—18 miles of 20-in. in Delaware County, Pennsylvania, and Gloucester County, New Jersey; and a twin underwater crossing of the Delaware River between Chester, Pennsylvania, and Bridgeport, New Jersey.

● **R. H. Fulton & Co., Box, 1526, Lubbock, Texas.**

Natural Gas Pipeline Co. of America—188 miles of 24-in. from Weatherford, Oklahoma, to Ashland, Kansas.

● **H. L. Gentry Construction Co., Drawer 32, Eckel Rd., Perrysburg, Ohio.**

Ohio Fuel Gas Co.—6 miles of 24-in. between Maumee and Toledo, Ohio, with R. L. Cantrell supervising.

Marathon Pipe Line Co. and *Ashland Pipe Line Co.*—three 8 and 12-in. creek crossings near Mansfield, Ohio, under the supervision of Edward Lee Wells.

● **Grayco Constructors, Inc., Box 4147, Austin, Texas.**

Midwestern Gas Transmission Co.—54 miles of 24-in. in Ottertail County, Minnesota. Headquarters: Detroit Lakes, Minnesota. Superintendent: E. E. Wilkerson.

● **Hall Construction Co., 1105 N. Carlton, Liberal, Kansas.**

Panhandle Eastern Pipe Line Co.—a 330-mile, 4 through 12-in. gathering system in western Kansas. Supervising are Mike Bell and M. E. Banning.

● **Harbert Construction Corp., Box 1369, Birmingham, Alabama.**

Michigan -Wisconsin Pipe Line Co.—85 miles of 16-in. from Weyauwega to Marinette, Wisconsin, and about 17 miles of 4-in. lateral lines, under the supervision of T. E. Walker.

● **Harford Bros. Co., Box 191, Emporium, Pennsylvania.**

East Ohio Gas Co.—25 miles of 16-in. between Austenburg and Warren, Ohio. Headquarters: North Jackson. Superintendent: Bob Mann.

The Manufacturers Light and Heat Co. — 22 miles of 6-in. between Farmington and Connellsville, Pennsylvania.

New York State Natural Gas Co.—a 13-mile welding job on 20-in. pipe with 1-in. wall thickness, near Tamarac, Pennsylvania, where field office is located. Whitey Martin is superintendent, and Monrowe Stevens welding superintendent. An undetermined amount of storage field pipe near Duboise, Pennsylvania, under the supervision of Elmer Landis.

● **Houston Contracting Co., 2807 Buffalo Speedway, Houston 6, Texas.**

Michigan-Wisconsin Pipe Line Co.—92 miles of 24-in. natural gas pipeline from Appleton to Marshfield, Wisconsin, with R. L. Silar as superintendent, R. R. Lytle as assistant superintendent, D. L. Marley as field office manager, and present headquarters at Stevens Point.

Midwestern Gas Transmission Co.—55 miles of 24-in. in Minnesota from the vicinity of Little Falls, where field office

is located, to the vicinity of Dalbo. M. L. Thompson is superintendent, Talmadge Crabtree assistant superintendent, and G. A. Warner field office manager. Also, 53 miles of 24-in. from the vicinity of Deronda, Wisconsin, northwest to the vicinity of Dalbo, Minnesota, A. J. Slovack is superintendent, L. L. Patterson assistant superintendent, and Jack Hensley field office manager at Dresser, Wisconsin.

Texaco, Inc.—11 miles of 20-in. gas pipeline from Paradis, Louisiana, to the Mississippi River. L. A. Young is superintendent, K. W. Berlin assistant superintendent, and Joe Puckett field office manager.

● **Latex Construction Co. of Georgia, Box 12128, Atlanta, Georgia.**

Plantation Pipe Line Co.—73 miles of 8-in. and take-up of an equal amount of 4-in. between Helena and Montgomery, Alabama. Field office: Thorsby. Superintendent: E. L. Myrick.

● **C. S. LeNoir Construction Co., Box 798, Austin 64, Texas.**

Northern Natural Gas Co.—110 miles of 16-in. from Albert Lea, Minnesota, to LaCrosse, Wisconsin. Field office: Blooming Prairie, Minnesota. Superintendent: W. B. Williams.

● **M & R Pipeliners, Inc., Elizabeth, Pennsylvania.**

Hope Natural Gas Company—19 miles of 20-in. in West Virginia, consisting of 9 miles between Kennedy station and Dry Fork and 10 miles from Ellenboro to Schultz.

● **Majestic Contractors Ltd., 49 Jackes Ave., Toronto 7, Ontario, Canada.**

Federated Pipe Lines Ltd.—14 miles of 6-in. and 19 miles of 6 through 8-in. crude oil pipeline in the Swan Hills area, Alberta, under the supervision of K. B. Killingsworth and Jeff Minter. Also, 41 miles of 16-in. from Oliver to Highbridge, Alberta, under the supervision of Jeff Minter at Morinville.

Trans-Northern Pipe Line Co.—relocation of a products pipeline in the vicinity of Toronto, Ontario, under the supervision of George Oswald at Cooksville.

Union Gas Co. of Canada Ltd.—12 miles of 8-in. on the Woodstock-Norwich line in Ontario, with Don Elliott supervising at Norwich.

Trans-Canada Pipe Lines Ltd.—a 50-mile, 30-in. extension from station No. 41 near Ile des Chenes to about 7 miles east of Emerson, Manitoba, with K. B. Killingsworth supervising at Morris, Manitoba.

Michigan-Wisconsin Pipe Line Co.—60 miles of 30-in. near Joliet, Illinois, where R. L. Leonard is supervising.

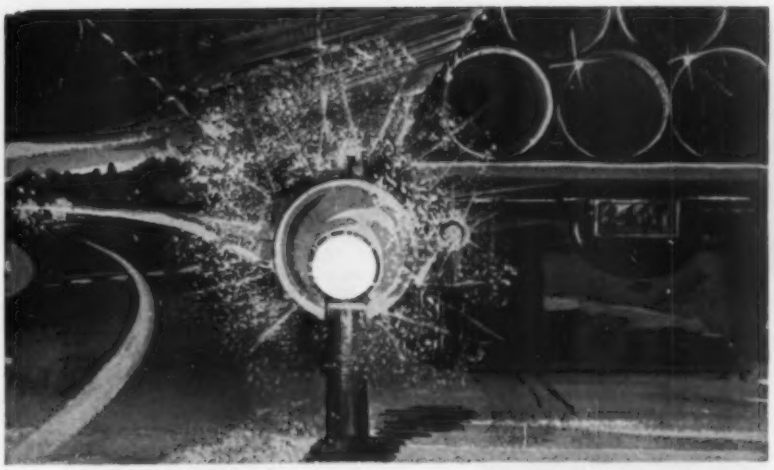
● **Mannix Co. Ltd., 737 Eighth Ave., S.W., Calgary, Alberta, Canada.**

Pembina Pipe Line Ltd.—70 miles of 3 through 10-in. in the Pembina oil fields of Alberta, part of a continuing contract of which over 500 miles have been constructed to date. Headquarters: Drayton Valley. Superintendent: S. Steffen.

Northern Ontario Pipe Line Crown Corp.—compressor station with building extensions at Port Arthur, Ontario—part of the Trans-Canada Pipe Line system. J. Hobbs is superintendent and M. Zambory office manager at Kenora.

● **McVean and Barlow, Inc., Box 151, Odessa, Texas.**

Mid-America Pipeline Co.—231 miles of 4, 6, and 8-in. LPG pipeline from Artesia, New Mexico, to Midkiff, Texas, under a sub-contract from Williams Bros. Co.



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● **Missouri Valley Dredging Co., Box 1592, Burlington Station, Omaha 8, Nebraska.**

Midwestern Gas Transmission Co.—a dual 24-in. crossing of the Chippewa River near Chippewa Falls, Wisconsin, where field office is located. Superintendent: Eldon A. Sumrall.

● **Montin-Harbert Pipe Line Construction Co., Inc. 2808 First National Bldg., Oklahoma City, Oklahoma.**

Mustang Fuel Corp.—an 8 and 12-in. natural gas pipeline system in central Oklahoma. This is a joint contract with Sadler Bros. Pipeline Construction Co.

● **Panama, Inc., 1801 Tennessee Bldg., Houston 2, Texas.**

Midwestern Gas Transmission Co.—66 miles of pipeline from the Chippewa River to Marshfield, Wisconsin.

● **Panama-Williams Corp., 1418 Melrose Bldg., Houston, Texas.**

Northern Natural Gas Co.—150 miles of 30-in. loops in Iowa, Minnesota, Nebraska, Kansas, and Oklahoma, under the supervision of M. E. Sutton at Clarion, Iowa.

Peoples Gulf Coast Natural Gas Pipeline Co.—60 miles of 30-in. pipeline from Nacogdoches, where field office is located under the supervision of W. H. Shiflett, to Leggett, Texas.

● **Parkhill Truck Co., Box 3807, Tulsa, Oklahoma.**

Natural Gas Pipeline Co. of America—pipe stringing under a sub-contract from River Construction Co. for loops in Iowa. Superintendent: Leon Weston.

Northern Natural Gas Co.—pipe stringing under a sub-contract from Panama-Williams Corp. for various loops in Iowa, Minnesota, Nebraska, Kansas, and Oklahoma. Field office: Ogden, Iowa.

● **Pentzien, Inc., 1504 Dodge St., Omaha, Nebraska.**

Natural Gas Pipeline Co. of America—a dual 30-in. Illinois River crossing near Plattsmouth, Nebraska, with headquarters at Omaha and James R. Zeman supervising.

Midwestern Gas Transmission Co.—a dual 24-in. crossing of the St. Croix River near St. Croix Falls, Wisconsin, where headquarters is located, under the supervision of T. D. Stout.

Texas Eastern Transmission Corp.—a single 20-in. Arkansas River crossing near Little Rock, where field office is located, under the supervision of James E. Garner.

Arkansas Industrial Pipe Line Corp.—a dual 18-in. Arkansas River crossing near Wright, Arkansas. Superintendent: T. D. Stout. Field office: Pine Bluff.

● **Pipe Line Technologists, Inc., 3431 Alabama, Houston, Texas.**

Seadrift Pipeline Corp.—a 108-mile products pipeline from Union Carbide Corp.'s Seadrift, Texas, plant to Humble Oil & Refining Co.'s King Ranch plant at Ella, Texas.

● **Pipeline Welding Co., 5100 E. 17th St., Tulsa, Oklahoma.**

Northern Natural Gas Co.—163 miles of 3 to 24-in. in Minnesota.

● **Popich Marine Constructors, Inc., Box 26343, New Orleans, Louisiana.**

Midwestern Gas Transmission Co.—a crossing of the Mississippi River.

● **Prairie Construction Co., Box 1526, Lubbock, Texas.**

Northern Natural Gas Co.—114 miles of 2 to 12-in. in Iowa.

● **H. C. Price Co., Price Tower, Bartlesville, Oklahoma.**

Midwestern Gas Transmission Co.—55 miles of 24-in natural gas pipeline in Minnesota from a point near Belle Prairie in Morrison County to a point near Bluffton in Ottertail County. This spread, headquartered at Staples, is under the supervision of G. A. "Abe" Reutzel.

Peoples Gulf Coast Natural Gas Pipeline Co.—83 miles of 30-in. in Missouri and Illinois, with W. L. Olrich as superintendent and Murphysboro, Illinois, as headquarters.

Texas Eastern Transmission Corp.—in Pennsylvania, 23 miles of 20-in. with Elwood Roth as superintendent, 42 miles of 24-in. with C. E. Shivel as superintendent and Lewiston as headquarters, and 39 miles of 24-in. with C. R. Ice as superintendent and Renovo as headquarters.

Rocky Mountain Natural Gas Co., Inc.—30 miles of gathering lines in the Colbran, Colorado, area; and a 65-mile, 8-in. transmission system south from the Colbran area, across the Grand Mesa, and into the valley of the Gunnison river and its tributaries. Field office: Delta. Bill Millburn is office manager, and K. N. "Spike" Adkins is in charge of construction of the cross-country line.

● **R. E. Reutzel Co., Box 15, Fremont, Nebraska.**

Northern Natural Gas Co.—89 miles of 2 to 6-in. in Iowa.

● **River Construction Corp., Box 9127, Fort Worth 7, Texas.**

Natural Gas Pipeline Co. of America—95 miles of 36-in. in Iowa, from Haskins to Rose Hill and from Stennett to Pacific Junction. Field office: Washington, Iowa.

● **Robb Construction Co., Ltd., 1237 Albert St., Regina, Saskatchewan, Canada.**

Saskatchewan Power Corp.—the Assiniboia and Ormiston-Claybank transmission lines, consisting of approximately 104 miles of 6 and 4-in. L. Brassard is superintendent.

● **Rosson-Richards Companies, Box 35037, Houston 35, Texas.**

Midwestern Gas Transmission Co.—24, 30, and 36-in. river weights between Minnesota and Wisconsin. Superintendent: T. L. McPherson.

Natural Gas Pipeline Co. of America—24, 30, and 36-in. river weights between Clinton, Oklahoma, and Chicago, Illinois. Superintendent: J. Alexander.

Peoples Gulf Coast Natural Gas Pipeline Co.—24, 30, and 36-in. river weights between Katy, Texas, and Chicago, Illinois.

● **Sadler Bros. Pipeline Construction Co., 617 Cravens Bldg., Oklahoma City, Oklahoma.**

Mustang Fuel Corp.—an 8 and 12-in. natural gas pipeline system in central Oklahoma. This is a joint contract with Montin-Harbert Pipe Line Construction Co., Inc.

● **Sherman, Allen, Gay & Taylor, Inc., Box 13152, Houston, Texas.**

Alaska Pipe Line Co.—a dual 12-in., 10-mile crossing of Turnagain Arm, with Chester Lake as superintendent and Anchorage, Alaska, as headquarters.

Kenai Pipe Line Co.—20 miles of 8-in. pipe from Mikiski Terminal to Swanson River Unit, 9 miles north of Kenai,

Alaska, where headquarters is located. T. L. Beard is superintendent.

Texas Eastern Transmission Corp.—20 miles of 30-in. near St. Francisville, Louisiana, and about 18 miles of 30-in. near Clinton, Mississippi. Field office: St. Francisville. Superintendent: E. D. Singleton.

● **Somerville Construction Co., 6648 Fulton Rd., Ada, Michigan.**

Michigan-Wisconsin Pipe Line Co.—70 miles of 30-in. pipeline loops between a point north of Sparta and a point near Niles, Michigan. Field office: Rockford. Superintendent: Harold Cook.

● **Stanley-Bledsoe Corp., 612 Daniel Bldg., Tulsa 3, Oklahoma.**

Peoples Gulf Coast Natural Gas Pipeline Co.—57 miles of 30-in. Shelby County, Illinois, northerly through Moultrie County to a point of tie-in to the main line. Piatt County. Headquarters: Sullivan. Superintendent: Denver L. Franklin.

● **Stelco, Inc., 905 Barton Springs Rd., Austin, Texas.**

El Paso Natural Gas Co.—an undetermined amount of various size lines in the Shamrock field. Superintendents: Al Blanchard and W. K. Hancock.

● **Turriff-Burden, Ltd., Box 5216, Tulsa, Oklahoma.**

Iraq Petroleum Co. Ltd.—315 miles of 30 and 32-in. pipeline from Kirkuk to the Syrian border, connecting Rumaila and Fao. W. T. Barker manages the project office in London, England. Field construction superintendent is John H. Miller; assistant superintendent is Arnold Smith; and manager of the field office in Baiji, Iraq, is G. E. Suagee.

● **Underground Constructors, Dodge Center, Minnesota.**

Northern Natural Gas Co.—28 miles of 3 to 6-in. in Iowa.

● **Western Pipe Line, Inc., Box 1076, Austin 66, Texas.**

Texas Eastern Transmission Corp.—35 miles of 30-in. in Pennsylvania, with field office at Lebanon; and 45 miles of 30-in. in West Virginia and Pennsylvania, with field office at Moundsville, West Virginia. W. E. Wells is superintendent of the former, J. R. Wells is superintendent of the latter, and R. L. McMillon is general superintendent for both.

Texas Gas Transmission Corp.—55 miles of 2¾-in. near Bedford, Indiana.

● **Williams Bros. Co., National Bank of Tulsa Bldg., Tulsa, Oklahoma.**

National Iranian Oil Co.—a 240-mile, 8-in. petroleum products line in Iran from Rey, near Tehran, northeast to Sharud.

Alaska Pipeline Co.—74 land miles of 12-in. pipeline from the Kenai Unit gas field to Anchorage, Alaska.

The Manufacturers Light and Heat Co.—70 miles of 20-in. from Bethel to Abbottstown, Pennsylvania. Field office: Gettysburg. Superintendent: Thelmer Davis.

Transok Pipe Line Co.—43 miles of 24-in. from Oolagah to Jenks, Oklahoma. Field office. Catoosa. Superintendent: Thelmer Davis.

Michigan Consolidated Gas Co.—47 miles of 30-in. from Elsie to Sixlakes, Michigan, with headquarters at Alma. Earl Saulsman is superintendent.

Mid-America Pipe Line Co.—four construction spreads have now completed 541 miles of this 1800-mile LPG pipeline.

● **C. E. Wilson Construction Co., 3718 W. 95th St., Kansas City 15, Missouri.**

Cenex Pipeline Co.—an 8-in. products system in Montana and North Dakota. This is a joint contract with D. Michael Curran & Co.

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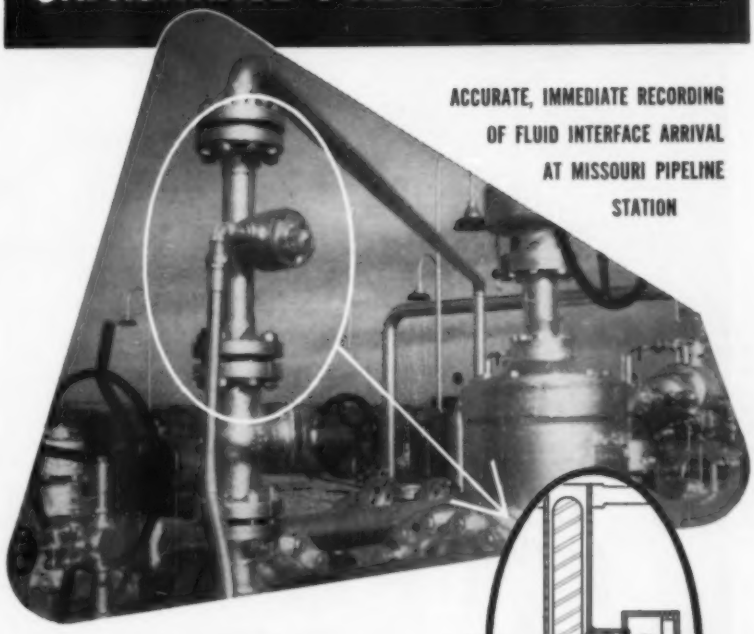

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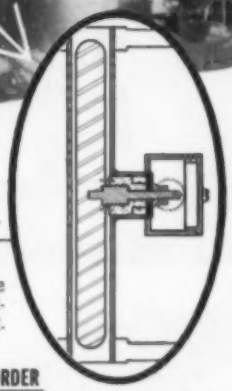

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For local recording with weather-proof housing. Connected by coaxial cable and located over 200' from probe.

CPA measures and records interface, water content or component changes in the fluid stream by measuring dielectric differences of fluid passing through a probe. Recording is on 12" round chart.

SPECIFICATIONS

Range of Measurement: 4.3 MMFD minimum and 1100 MMFD maximum (equal to 1% min. and 35% max. for water in oil)

Accuracy: Within 0.5 of 1% of actual capacitance indicated (equal to ± 0.15 of 1% water in oil)

Sensitivity: Standard — 0.043 MMFD equivalent to 0.01 of 1% water contamination in oil

Power: 115 volt, 60 cy. A.C.

Recorder Motor: Electric or spring wound

Recording: Local — at or near point of measurement; Telemetering — over any pair of telegraph grade wires; Pneumatic — provides air signal at distant point

Housing: Explosion-proof or weather-proof

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Probes: 2", 3" and 4" flanged, grooved or threaded

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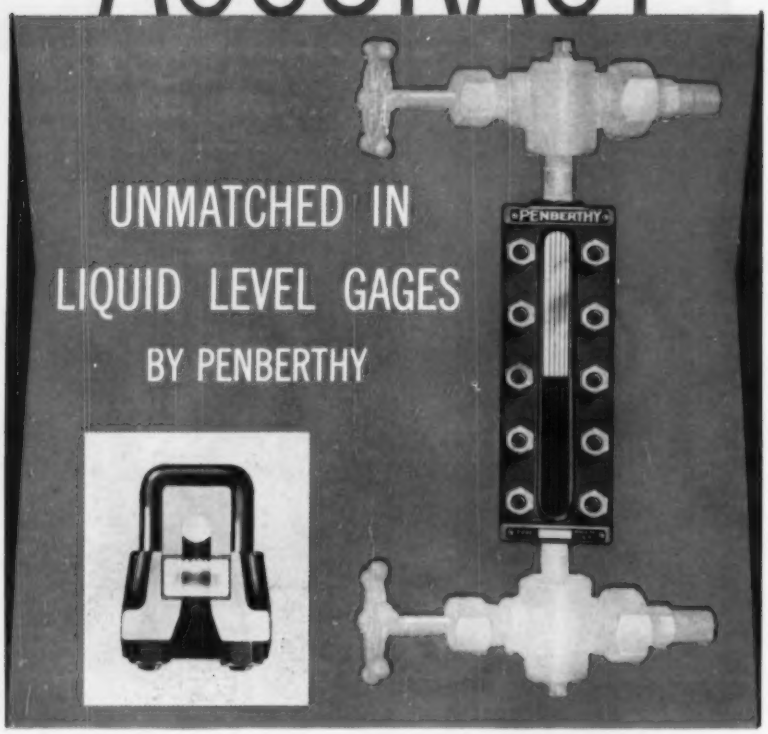

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PIPELINE PERSONALS

Plantation Pipe Line Company has elected as vice president-treasurer and a director, **Silas V. Kane,** who was active in organizing the company and planning initial construction of its pipeline system. He was assistant secretary-treasurer when the company started operations in 1942 and was made secretary-treasurer in 1943. **Walter B. Mackenzie** has been elected secretary.

Announced is the consolidation of the Dallas district of United Gas Pipe Line Company and the Tyler district of Union Producing Company and the appointment of **F. B. Winbery,** manager of the Dallas pipeline district, as manager of the consolidated district, with main offices to be located in Tyler, Texas. The district's dispatching department will be moved to the United Gas Pipe Line Company office in Carthage, Texas, and the chart department will be transferred to the United Gas general office in Shreveport, Louisiana. When consolidation is completed, the Dallas district pipeline office will be closed.

Robert E. Roehl has rejoined Cities Service Company following a one-year leave of absence to serve as coordinator of transportation for the oil and gas division of the U. S. Department of the Interior. In his new capacity, he will be affiliated with Cities Service International, Inc., and coordinate foreign supply and transportation activities. Prior to his leave of absence, he served as assistant to the manager of transportaion and supply for Cities Service.

Fred W. Batten has been elected vice president and chief operations officer of The Columbia Gas System, Inc. He has served as vice president of Columbia Gas System Service Corporation since 1956.

Max P. Watson, a 23-year veteran with the United Gas organization, has been elected a member of the board of directors of United Gas Pipe Line Company. He also is assistant to the president of the United Gas Corporation and its wholly-owned subsidiaries, Union Producing Company and United Gas Pipe Line Company.

Promotions and transfers in Columbia Gulf Transmission Company's transmission and engineering departments include: **Charles W. Dommel,** named project engineer for compressor stations; **Max M. Levy, Jr.,** reassigned as project engineer, pipeline; and **Jack Spinks,** promoted from engineer to design engineer.

Appointed general chairman of the PIEA 1962 annual conference and exhibition is **Frank Geisel,** Atlantic Pipe Line Company.

James E. Moss has retired as director of the Division of Transportation of the American Petroleum Institute and is succeeded by **B. H. Lord, Jr.,** who joined the API staff in 1946 and has been the division's associate director during the last year. Moss will continue to serve as a special consultant on President **Frank M. Porter's** staff.

FOR FURTHER INFORMATION ON ADVERTISED PRODUCTS, SEE READER SERVICE CARD

Paul A. Sweeney, a career government employee with over 35 years of Federal service and first assistant in the Justice Department's office of legal counsel before being nominated to the Federal Power Commission to fill the unexpired term of the **late Commissioner John B. Hussey,** has taken the oath of office as a member of the FPC. The term expires June 22, 1963.

The newly-created position of assistant general superintendent for Sun Pipe Line Company's crude lines department in Beaumont, Texas, goes to **C. C. Wallace,** a 34-year veteran with Sun Pipe Line. Succeeding Wallace at Beaumont as Gulf Coast area superintendent for the firm's crude lines department is **Jesse D. Duplissey,** formerly superintendent of transportation and oil handling for Venezuelan Sun Oil Company. Named assistant to Duplissey is **James E. Ware** who has been serving as administrative assistant in the Beaumont office.

The promotion of William S. Davidson, Jr., from general superintendent of its western division pipeline department to manager of the eastern division transportation department is announced by Tidewater Oil Company. Davidson is successor to **Allen L. Piper** who was transferred to the company's western division.

Charles T. Klein's election as a vice president and director of Cities Service Gas Company fills a new position created by the company's board of directors. He formerly was manager of the natural gas division of Cities Service Oil Company (Del.) and a member of the company's board.

In a recent exchange of jobs in Texas Gas Transmission Corporation's operating department, effective for six months, **Ed Hamric** assumed the duties of supervisor, general engineering and construction, and **Clint Paulsen** was reassigned as assistant superintendent of the pipeline department.

In charge of all construction activities for R. H. Fulton and Company is the firm's new general manager, **Chuck Siewert.**

Mannix Company Ltd. has appointed as manager of contract development **Frederick G. Wilmot,** former western Canadian manager for Taylor Forge and Pipe Works.

New senior pipeline engineer in Columbia Gas System Service Corporation's gas engineering department is **Frank I. Dorr, Jr.,** formerly a project engineer with Columbia Gulf Transmission Company. Heading a new section in the department to develop applications for high speed computers for system engineering and operations is **John E. Towle,** formerly an engineer in the company's methods department.

Recent promotions in Trunkline Gas Company's engineering department, which is under the supervision of **Forbes Wilson,** assistant chief engineer, are: **R. C. Newsome,** manager of engineering design; **A. W. McAnneny,** manager of engineering planning; and **H. C. Williams,** administrative assistant to the chief and assistant chief engineers. Under McAnneny's management are: **L. V. Parent,** supervising engineer, planning; and **L. C. Sullivan,** supervising engineer, research. Under Newsome's direction is **J. B. Sellers,** supervising engineer, pipelines.

Walter E. Biery, president of Mid-Continent Pipe Line Company, has been elected president also of another Sunray subsidiary, Suntide Pipe Line Company, a crude oil gathering facility serving the Suntide Refining Company plant on Nueces Bay at Corpus Christi, Texas. He succeeds **Glenn E. Wynn** who now heads Sunray Chemical Company. Suntide Pipe Line officers re-elected include: **George W. Martin,** vice president; **John A. Vadas, Jr.,** assistant secretary and assistant treasurer; **Lewis Lacy;** secretary and **J. F. Ladd,** treasurer. Directors are: **Biery, Paul E. Taliaferro, R. Paul Henry, J. M. Linehan,** and **H. A. Brown.**

Elected president of Pan American Petroleum Corporation's natural gas transmission subsidiary, Pan American Gas Company, is **Bryan C. Edwards.** He succeeds **Gilbert F. Moore,** recently elected a director of Texas Gas Corporation.

Problem:*

to cut a pipe of tough 11% nickel-steel alloy, ¾" thick, 5" diameter.

Solution:

3 men, using 100 hack saw blades, cut this pipe by hand in one full working day.

OR . . .

One man, using a FEIN SAW, cut same pipe in 42 minutes. Original blade was good for many more hours of equally tough service.

**Actual job at a California Chemical Plant*

FEIN
Portable Power Hack Saw

Electrically or Pneumatically driven

The saw blade of high speed steel moves at a speed of 480 strokes per minute with a **2½" thrust.** Easily cuts any profile metal and steel or cast iron pipe up to 6" diameter. Driven by 250 Watt Universal Motor. 200 Watt 3 Phase motor or a 0.5 HP air turbine.

For further information and literature, see your dealer or write:

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GRamercy 7-7180

SALES REPRESENTATIVES:
Some sales territories available. Write for information.

It's New | Pipeline Equipment

Cuts From 0 to 45 Deg

Introduced for faster pipe cutting is the Fein portable power hack saw, the blade

of which cuts upward with a 2½-in. stroke at the rate of 240 per min. An electric or compressed air motor drives a counterbalanced crankshaft by means of a spiral bevel gear and converts the rotary motion into a reciprocating motion required by the saw blade. The blade shaft runs in guides mounted on ballbearing rollers. The machine is fixed to the work by a slide bolt on the clamping device, so that sawing pressure is gained by leverage obtained in pressing down the handle. The machine can be used for bevel cutting up to 45 deg angles by turning it around on the pin bearing which is graduated for this purpose. *Widder Sales Corp.*

Circle number (81) on reply card.

Rectifiers In Four Standardized Case Sizes

Complete, one-unit cathodic protection rectifiers are being offered to fit any one of four compact, small arms proof (11-gage steel) case sizes designed to meet most specific load requirements. Cases may be pole or platform mounted. Wide swinging doors, which may be padlocked, permit access to the equipment panel from front or side. Provided are condulet fittings for ease of input power connections and panel switch and overload protector in the primary circuits. Input voltage is 115-v, 60-cycle, single-phase. Each transformer is custom-designed and manufactured with sufficient safety factor for intermittent overloads and long life, the manufacturer states. Each size unit can be especially engineered with optional equipment to individual specifications. *EICOR, Div. of The Scranton Corp.*

Circle number (82) on reply card.

World's Largest 2-Cycle Gas-Engine-Compressor

A new, turbocharged, V-type, 2-cycle, gas-engine-driven compressor — built in 12 and 16 power cylinder models rated at 4000 and 5500 bhp — features compressor cylinders on one or both sides of the crankcase to make maximum use of available space and provide cylinder flexibility for a wide range of operating conditions. For gas transmission, the TCV can be furnished with cylinders featuring large internal manifolds streamlined to avoid turbulence and pressure drop, large area nylon poppet type valves that for all practical purposes eliminate maintenance, and oversize suction and discharge nozzles to keep velocities low. Featuring a 15½-in. crankshaft, the engine operates over a 180 to 300 rpm speed range. There are less components subject to wear and replacement in Clark's 2-cycle design. The TCV is equipped with two turbochargers, one for each bank of power cylinders, and an automatic ignition control. Turbocharger, along with external fin and tube type scavenging air intercooler, may be mounted on the engine or away from the engine, either inside or outside the building. *Clark Bros. Co., of the Dresser Industries.*

Circle number (83) on reply card.

11,000-15,000 MC Range Microwave Radio Line

An innovation featured in a new line of microwave radio equipment operating in the 11,000-15,000 mc range is a new temperature control chamber for the klystron. Chamber temperature is automatically controlled by a spring-operated mechanical device, with the klystron used as a heat source. Designed to provide terminal circuits for lower frequency systems entering congested areas and to open new frequencies for present licensees and others who do not presently have microwave radio systems, the MW-601 may be operated from either a-c or d-c primary power. Both transmitter and receiver are equipped with ferrite devices that protect the transmitter klystron from the effects of line and antenna mismatch, isolate the receiver preselector and mixer crystal, and prevent local oscillator radiation. *Collins Radio Co.*

Circle number (84) on reply card.

Transfers Data Over Microwave Relay

Announced is new data transmission multiplex equipment capable of transmitting 62,000 characters per sec over a microwave relay system and utilizing a single wide band subcarrier channel to achieve high speed transfer. Working from magnetic tape input, it converts data from parallel to serial form. Bits making up each character are regenerated and transmitted one after the other. A timing pulse is inserted after transmission of all bits in a character. At the receiver station, a serial to parallel converter stores individually received bits until a full character is accumulated. This is amplified and supplied to the magnetic tape recording head. Parity checking circuitry guards against loss of any bits during transmission. Should an error be noted at the receiving station, the equipment sends a signal back to the transmitting point, which backspaces and reruns the initiating tape. *Motorola, Inc.*

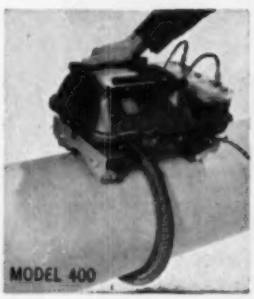
Circle number (85) on reply card.

Spy Detector

QUALITY SERVICE

is there . . . when you need it!

. . . our SPY HOLIDAY DETECTORS are as near as your telephone—in fact, in emergencies our own plane assures immediate service.



Rugged equipment for dependable holiday detection on ¾" to 36" pipe . . . signal—bell, light and spark . . . unaffected by dew or frost.

Call, wire or write.

Pipeline Inspection Co., Inc.

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For Temperature, Flow, Pressure Measurements

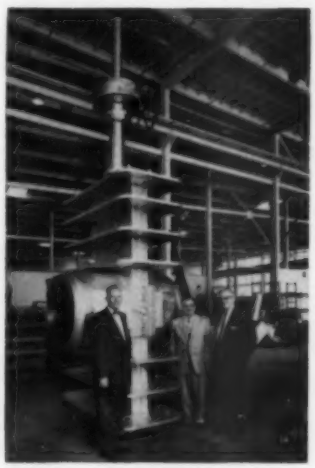
A new series of digital transducers measures pressure, flow, temperature, or other variables, and provides a digital output in the form of contact closures for data recording or transmission. They are completely mechanical, employing mechanical force amplifiers to drive Datex shaft position encoders from bourdon tubes, bellows, diaphragms, or similar devices, and are driven by a small electric motor. Explosion-proof models are available, as well as optional deviation or upset alarm detector, the former alerting the operator should measured variable deviate from its normal or previous magnitude, and the latter operating similarly to warn the operator should the rate at which the variable changes exceed preset limits. Standard Datex components are available for incorporating the DX-100 series units into a data recording or transmission system. *Datex Corp.*

Circle number (86) on reply card.

Pre-Built Building For Microwave Equipment

Developed exclusively for use with microwave equipment is a new factory prebuilt building that can be delivered to the site with all wiring and equipment installed prior to shipment. Field installation requires minutes. Intricate microwave equipment can be pre-installed at the factory. Only simple field tuning is required to make the unit entirely operational. When a move is necessary, the building need only be lifted from its special piers. *Tower Construction Co.*

Circle number (87) on reply card.

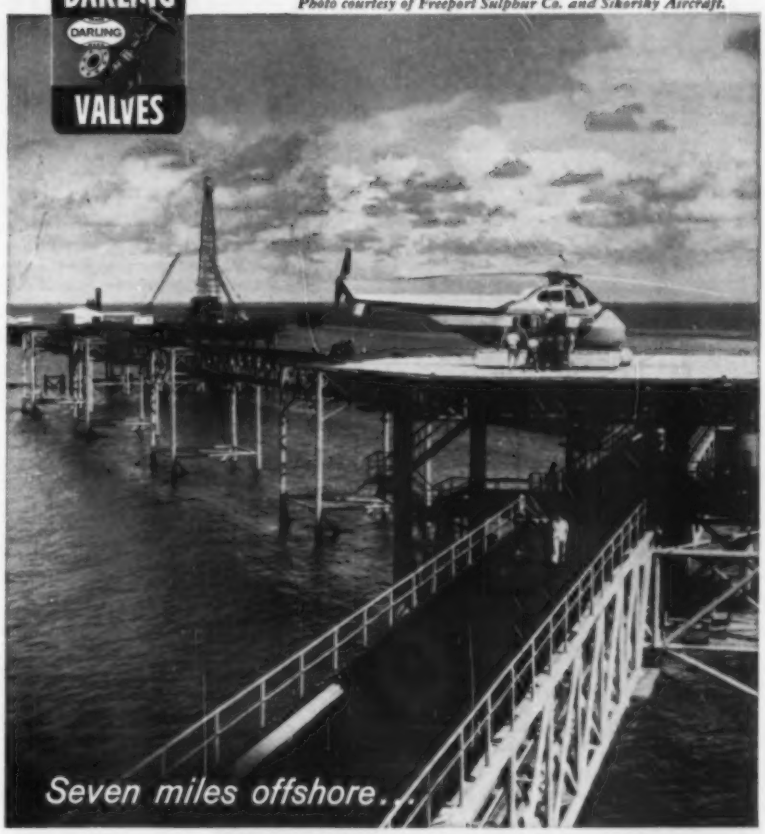


This is believed to be the largest through conduit gate valve ever to be put in pipeline service. It is a 36-in., class 300; stands over 18 ft tall; weighs 20,875 lb; is fabricated from steel plate; and incorporates "Seal-O-Ring" design, featuring a parallel faced gate that slides between floating seats. Instead of sealing compound, the seal is accomplished by polished metal seat rings with nitrile rubber "O" rings held against the gate. No lubrication is required. *Grove Valve and Regulator Co.*

Circle number (88) on reply card.

DARLING VALVES

Photo courtesy of Freeport Sulphur Co. and Sikorsky Aircraft.



90 DARLING VALVES

to help tap new sulphur deposit

Above you see part of Freeport Sulphur's $30,000,000 project to tap a major new sulphur deposit. It's the world's first offshore sulphur mining plant at Grand Isle... seven miles off the coast of Louisiana in the Gulf of Mexico.

Valves on the mile-long "steel island" mining plant were supplied by Darling. They include 2" to 12" OS and Y and 6" to 10" check valves made from Ni-Resist with monel trim ... all for use in corrosive service.

Here's another case where Darling's extensive research and development on corrosion-resistant valves helped solve a specialized operating problem. And on gate valves, Darling's *exclusive revolving double disc parallel seat feature* assures positive sealing and ease of operation at all times.

Let us assist *you* on applications where "just ordinary valves" won't do. Write or phone us about your valve requirements.

Darling OS and Y gate valve with flange ends . . . one of types being supplied for Freeport Sulphur's Grand Isle sulphur mining plant.

DARLING VALVE & MANUFACTURING CO.

Williamsport 2, Pennsylvania

Manufactured in Canada by Sandilands Valve Manufacturing Co., Limited, Galt 19, Ontario

Simplifies Welding

A new powered, portable pipe rotator headstock has been designed to simplify and speed welding. For field or in-plant, it positions, clamps, and rotates pipe, and is built in four sizes to handle pipe 1 to 48 in., with speeds ranging from 2 to 160 in. of circumference travel per min to make possible manual, semi-automatic, and full automatic welding. Featuring single lever operated, 3-jaw chuck and detachable self-contained variable speed electrical control unit, the rotator contains a built-in rectifier and operates on 110-v single-phase current. *World Electric Co.*

Circle number (89) on reply card.

Ball Valve To 36 In. Is Easy To Install

Using the principle of rotating seats—with no bonnets, no gaskets, no joints, and requiring no lubrication to seal bubble-tight—is a new compact, lightweight-for-its-class ball valve. It may be installed in the most convenient position—without regard to top or bottom—and is compatible with all types of electric, pneumatic, and hydraulic operations — according to the manufacturer. Two-seat construction seals both upstream and down. Thus, the line may be blocked in both directions and the body of the valve bled off. Each time the valve is operated, the spaces between seats and in the body cavity are flushed out. The ball valve's simple design makes possible special material construction for high temperature or corrosive applications. It is available in sizes from 2 to 36 in. for 150 through 600 lb ASA classes and in 2 through 6 in. for API 1000 psi to 5000 psi working pressure rating. *Cameron Iron Works, Inc.*

Circle number (90) on reply card.

Pipe Beveling Unit Cuts On Short Segments

Announced is a new pipe beveling machine design that features a shorter, balanced ring gear-saddle assembly making it possible to cut on shorter segments of pipe. Described as a compact, easier to use unit, the newly designed machine is said to reduce storage space by approximately one-half. The new design also cuts excessive weight from the machine. *C. A. Mathey Machine Works, Inc.*

Circle number (91) on reply card.

New "Floating Cone" ¼-In. Hand Valve

Positive shutoff and freedom from galling are features of a new "floating cone" ¼-in. hand valve recommended for liquid or gas service on meter manifolds, seal chambers, hydraulic equipment and similar applications. Instead of the conventional one-piece plug and stem, the stem of the new cone valve terminates in a socket which holds the knuckle of a conical shape plug. With the plug firmly seated at closure, the stem is free to rotate on the knuckle surface; no amount of further tightening will score the polished cone. Teflon ring packing keeps friction to minimum, requires no lubrication. Bonnet is precision aligned with body for accurate seating of plug; bonnet seat checks rise of stem and provides seal to permit repacking at full line pressure. The new valve is supplied in five variations of globe and angle types, accommodating line pressures up to 3000 psi. *The Foxboro Co.*

Circle number (92) on reply card.

Soil Resistivity Prod Has Replaceable Head

A replaceable head on a new soil resistivity prod bar permits savings because it eliminates the necessity of the bar being discarded when wear has reduced tip size. The Agra prod — a single bar incorporating two electrodes—simply and easily determines soil resistivity when used with the proper instrument. Its design incorporates a ½-in. round section of tough steel for all but the bottom few inches of the shank, permitting easy entry into the hardest of soils without impacting or hammering, the manufacturer states. It also serves as a contact bar. Standard length is 44 in. *Agra Engineering Co.*

Circle number (93) on reply card.

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CON STRUC TION

Review/Forecast Issue

1st

IN CORROSION PREVENTION

BITUMASTIC
REG. U. S. Pat. Off.
HOT & COLD APPLIED COATINGS

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PIPELINE FELT, PADDING & GLASS PIPE WRAP

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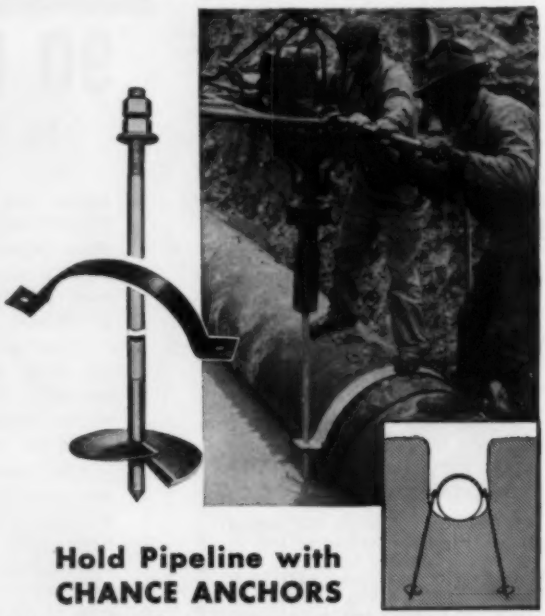

Hold Pipeline with CHANCE ANCHORS

Costs: 85% Less . . . Easier to Install . . . Less Weight to Handle

You can make a better bid, do a better job, do it easier, and make more money with Chance pipeline screw anchors. The cost saving is fantastic, and Chance field engineering and installation service will even do the work.

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INTERNATIONAL DIVISION • CENTRALIA, MO., U. S. A.

It's New | Pipeline Literature

Line Pipe Facts . . . and specifications of line pipe produced by Youngstown . . . are found in an 8-page brochure designed for easy filing. Graphic descriptions of the three methods by which Youngstown makes line pipe (continuous weld, seamless, and electric weld) . . . and a section devoted to the hydrostatic expansion process . . . are included with technical matter of concern to buyers. *Youngstown Sheet and Tube Co.*

Circle number (94) on reply card.

Glossary of Liquid Metering Terms . . . for users who find that they have to know more about meters than where to bolt them on. Understanding meters frequently seems more difficult than it actually is because the terms are strange or misunderstood, Rockwell engineers find. To clarify some of these points, they have compiled this glossary of terms used in liquid metering. *Rockwell Manufacturing Co.*

Circle number (95) on reply card.

Bulldozer in Action . . . on the cover of a new 32-page book . . . introduces the 100-hp diesel Eimco 103 crawler-tractor line. Inside pages are illustrated with features of this tractor series; specifications are included; as are schematic drawings and coded listing of performance and other features. *The Eimco Corp.*

Circle number (96) on reply card.

"Timely Tractor Tips" headlines a new two-pager. It recommends a procedure to attain longer clutch life when parking a crawler with the engine running; and points out some safety rules. *International Harvester Co.*

Circle number (97) on reply card.

"Simple Talk About A Simple Flowmeter" discusses, in elementary terms, the new vortex-velocity principle of fluid flow measurement and operation of Rotron's line of "Whirl-Flo" flowmeters based on this principle. *Rotron Controls Corp.*

Circle number (98) on reply card.

A Field Manual has been specially prepared for the pipeline contractor to bring to his attention all phases of construction techniques and costs of the Polyethylene tape method. *Safe-T-Clad Div., The Seamless Rubber Co.*

Circle number (99) on reply card.

"Mathematical Applications of the Dynamic Storage Analog Computer" details applications, including the use of continuous memory for solution in 30 sec of complex transient operations and difference-differential problems. Full schematics of computer circuitry illustrate solution of problems discussed. *Computer Systems, Inc.*

Circle number (100) on reply card.

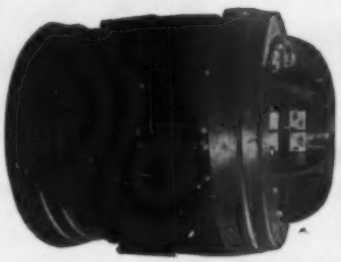
An Equipment Catalog . . . describing "Unionarc" welding machines, torches, and supplies . . . is one of two new pieces of literature on Linde's semi-automatic, flux-and-CO_2-shielded process for welding steel. The other is a 12-page booklet containing illustrated case histories of the process in industrial applications. *Linde Co., Div. of Union Carbide Corp.*

Circle number (101) on reply card.

Design Considerations, mechanical and hydraulic, for two stage centrifugal pipeline compressors are detailed in a new illustrated bulletin. *Clark Bros. Co., One of the Dresser Industries.*

Circle number (102) on reply card.

MOLE
Pipeline Cleaner



for BETTER cleaning of
CRUDE LINES
PRODUCT LINES
NATURAL GAS LINES

FOR DETAILS WRITE
Pipeline Cleaners Co.
Fort Madison, Iowa

Write for Bulletin

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PIPELINE VENTS AND MARKERS

FLEET-LINE CO.
P. O. BOX 276-A
SHREVEPORT
LOUISIANA

Oakite cleaning methods pay off fast. At pumping stations they help step up product flow, save time, reduce maintenance costs. Take these typical operations, for instance:

Diesel parts cleaning. A short soak in Oakite Saturol removes every trace of carbon, varnish, lacquer, gum, grease ... yet hand brushing is eliminated.

Lube oil cooler maintenance. Oakite Compound 85 does double duty — removes both grease and scale in a single operation. Units go back on stream faster, and at full rated capacity.

Cleaning electrical equipment. For maintenance of generators, control panels and electric motors, Oakite Composition 117 is the specific-purpose solvent with the two essential qualities you want: high flash-point and quick loosening of soil.

These and similar operations at pipeline pumping stations are discussed in a new Oakite Service Report, B6878. For a free copy of this helpful report, write to Oakite Products, Inc., 51A Rector Street, New York 6, N.Y.

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Technical Service Representatives in Principal Cities of U. S. and Canada

OAKITE
over 50 Est. 1909 years' leadership in industrial cleaning

McCORD

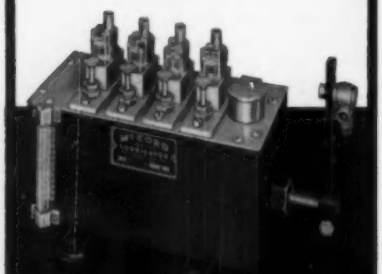
MODEL "55"

A Better LUBRICATOR

McCORD Model 55 pumps are interchangeable with McCORD Type "SF"

Most Accurate Lubricator Ever Developed

1. **DRY SIGHT FEED** — No glycerine—No Maintenance.
2. **CALIBRATED DROP** — A McCord First—Makes the Model "55" the most accurate lubricator ever developed.
3. **POSITIVE** — No possibility of undetected leakage.
4. **UNIT CONSTRUCTION** — Entire pump assembly accessible by removal of 2 capscrews.
5. **HIGHEST PRESSURES** — Easily handled with standard lubricator.
6. **LONGER LIFE** — Due to longer plunger and more sealing area.



SPECIFY McCORD AND *Be Sure*

Send for your copy of the interesting bulletin on McCORD MODEL "55" LUBRICATOR.

Lubricator Division

McCORD CORPORATION

Detroit 11, Michigan

Telemetering . . . including features of the ASCOP telemetry system, typical line costs and line capacities, how the system works in simple terms, and typical systems . . . is the subject of a new 8-page brochure. *ASCOP Div., Electro-Mechanical Research, Inc.*

Circle number (103) on reply card.

Motor Catalog . . . 56 illustrated pages dealing with a-c multi-shielded motors and featuring a special section on motor selection and application. Dimensional data on motors of this type, ranging from ¼ to 200 hp, are included, plus information for various modifications such as specialized mountings and enclosures. *Sterling Electric Motors, Inc.*

Circle number (104) on reply card.

A New Catalog Supplement offers new information on the flexibility available in butterfly valves for control of large volumes of liquids or gases. It pictures typical variations of light and heavy-duty wafer style valves; describes the three basic body designs — swing-through, angle seating, or soft seat; and shows a variety of valve actuators and special arrangements, including spring-diaphragm actuators, auxiliary handwheels, special shaft extensions for liquid oxygen service, cylinder actuators, and electric actuators and positioners. *Mason-Neilan, Div. of Worthington Corp.*

Circle number (105) on reply card.

"Voice Director" . . . a pocket radio message receiver . . . is the subject of a new four-pager. A dispatcher or secretary using regular two-way radio equipment can transmit voice directions to personnel equipped with the receiver unit, which operates in the 150-174 mc frequency range. *General Electric Communications Products Dept.*

Circle number (106) on reply card.

Replaceable Thermocouple Components . . . bare elements, elements with insulators, insulators, metal and ceramic protecting tubes, heads, blocks, connectors, and miscellaneous fittings . . . are the subject of a new 28-page catalog, with specifications and ordering information. *Minneapolis-Honeywell Regulator Co.*

Circle number (107) on reply card.

Pipe Connections Manual . . . in 44 pages contains all new types and ratings of Grayloc clamps, collar-type unions, flanges, vessel nozzles, closures, and bleeder valves, and features an exclusive 10-page table of allowable working pressures for pipe and connections from 1 to 30 in. inclusive to 1500 F. *Gray Tool Co.*

Circle number (108) on reply card.

To Compensate Fluid Flow for variations in pressure and temperature are electric and pneumatic systems . . . illustrated in a new two-page bulletin. *Bailey Meter Co.*

Circle number (109) on reply card.

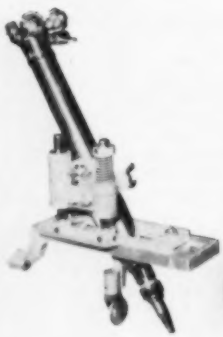
Sour Crude and Tank Farm are among the applications recommended for 2 through 12-in. ductile iron gate valves . . . explained and illustrated in a new bulletin. *Crane Co.*

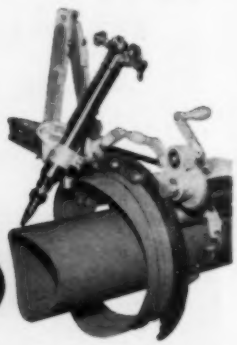
Circle number (110) on reply card.

Patent No. 2,843,373

make the TOUGH JOBS EASY with H&M

Patent applied for





H&M OUT-OF-ROUND for imperfect pipe
Features a free-wheeling roller assembly that swivels a full 360° — rides the pipe surface and is controlled by a unique spring tension that makes corrections for any eccentricities — eliminates inaccurate cuts and bevels.

H&M SHAPE CUTTER for intersectional cutting
Cut saddles and miters for the fabrication of tees, els and other irregular designs simply, easily with the H&M Shape Cutter. The machine uses pattern templets to insure accurate cutting and produce precision design work.

The Shape Cutter and Out-of-Round are available in a full range of sizes to fit all H&M Pipe Cutting and Beveling Machines. Write for catalog sheets on the complete H&M line, Today!

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TULSA, OKLAHOMA

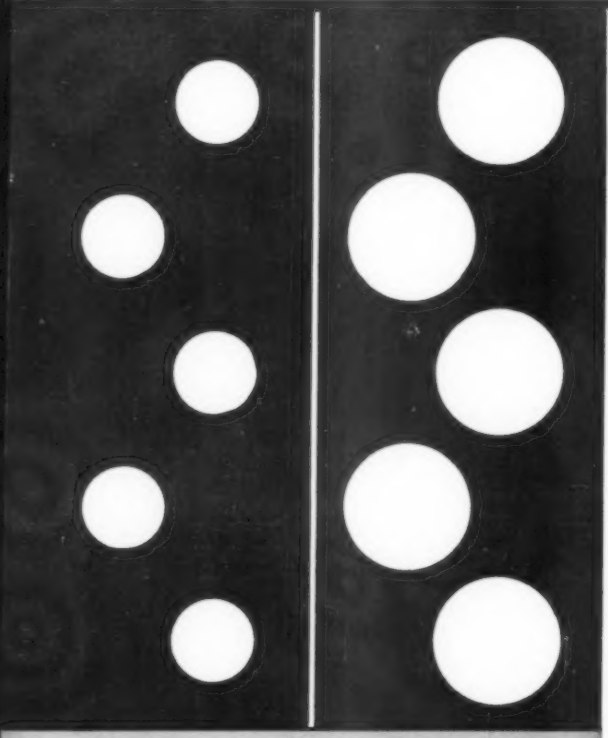
Another FIRST by LANE-WELLS

BIG HOLE PERFORATING

For Formation Treating

56% LARGER Diameter • 144% LARGER Opening

780 SUPER E BULLET



Comparison of area of standard perforations (above, left) and 780 Super E perforations (above, right).

You are looking at the actual size of perforations produced by Lane-Wells new 780 SUPER E BULLET Perforating. Compare these holes with the size of perforations produced by standard bullets—compare the hole size with even smaller holes by other types of perforating.

Designed especially to produce a large hole and maximum formation cracking, the 780 SUPER E BULLET really paves the way for hydraulic fracturing, explosive fracturing, acidizing, and other types of formation treatments. Because the 780 SUPER E BULLET is fired by a standard Lane-Wells Type E gun, you get all the advantages of selective firing and proved performance.

Ask your nearest Lane-Wells representative about this newest service by the company that originated perforating for the petroleum industry!

You're AHEAD with
Lane-Wells' Superior Service

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EXPANDING ORBITS OF SERVICE

Expansion of its services is not new at Halliburton. From its beginning, Halliburton Oil Well Cementing Company expanded through research and development of new ideas that serve the oil and gas industry.

Now we've changed our name to Halliburton Company, to emphasize the *multi-service* scope to which we've grown.

Continue to look to Halliburton Company for *leadership* in cementing, formation fracturing, testing, chemical services, and a wide range of other oil field services.

Halliburton Company's expanding orbits of service will continue to mean the *very best* in quality and performance for its customers . . . worldwide.

Halliburton COMPANY

DUNCAN, OKLAHOMA